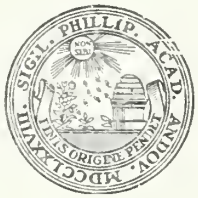

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NUMBER SEVEN

THE POTTERY OF PECOS

GLAZE-PAINT, CULINARY, and OTHER WARES

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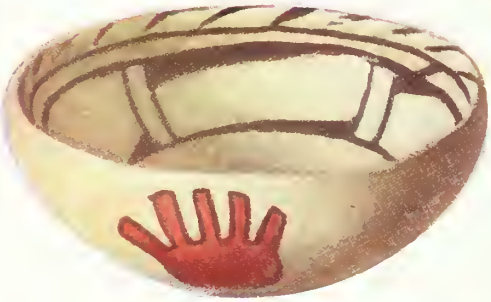

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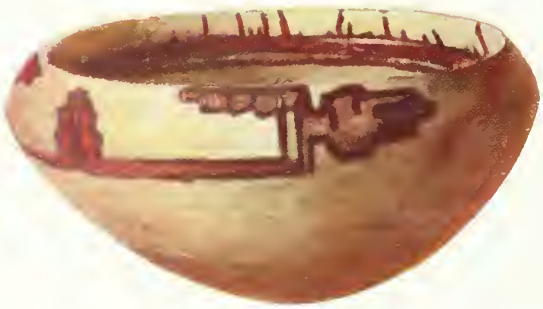

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GLAZE BOWLS

a: Glaze I Red. *b:* Glaze I Yellow. *c:* Glaze II. *d:* Glaze III. *e:* Glaze IV. *f:* Glaze V. *g:* Glaze VI. (*ca* 1/4 except *f*, which is *ca* 1/6.) Paintings by T. Amsden.

DEPARTMENT OF ARCHAEOLOGY
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WARREN K. MOOREHEAD, DIRECTOR
WITH CO-OPERATION BY
CARNEGIE INSTITUTION OF WASHINGTON
AND
THE LABORATORY OF ANTHROPOLOGY

THE POTTERY OF PECOS

Volume II

I

THE GLAZE-PAINT, CULINARY, AND OTHER WARES

BY

ALFRED VINCENT KIDDER

II

THE TECHNOLOGY OF PECOS POTTERY

BY

ANNA O. SHEPARD

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INTRODUCTION

By A. V. Kidder

In the first volume of this work[1] there were described the three Pecos wares decorated with matte pigment: Black-on-white, Biscuit, and Modern. The present report concerns itself with all other sorts of pottery which came to light at Pecos, namely: Glaze decorated wares, Undecorated Smooth wares, and Culinary wares. There is also considered such pottery of surely non-local manufacture as found its way to the pueblo. To make clear the chronological relationship of the above groups it is necessary briefly to outline the ceramic history of Pecos.

The first settlement of the Pecos region by sedentary, pottery-making Indians seems to have taken place during the Great Pueblo period,[2] at which time a number of small communities established themselves in the upper Pecos valley and in the country to the east. The decorated pottery of these pioneers was a Black-on-white ware allied to that of other Great Period groups to the west and northwest.[3] The excavations of the Academy at Forked Lightning, Rowe, Dick's Ruin, and the ruin on Loma Lothrop, all sites in the upper Pecos valley, produced much ceramic material to illustrate this early phase. The Forked Lightning specimens have been described by Mr. Amsden in the first volume.

Toward the close of the Great Period, seemingly about 1300 A.D., all the outlying villages except that on Loma Lothrop and one near Glorieta were abandoned; and Pecos was founded, probably by the inhabitants of the nearby Forked Lightning village, who no doubt were reinforced by people from some of the other small towns. Black-on-white pottery was still in vogue, and continued in use at least

[1] Kidder and Amsden, 1931.

[2] I follow the nomenclature recently suggested by Roberts (1935, p. 32):

"Basket Maker: to designate the stage at present indicated by the titles Basket Maker II or Classic Basket Maker.

Modified Basket Maker: this would replace Basket Maker III, Late Basket Maker, or Post Basket Maker. The designation would have the merit of indicating that the level was basically Basket Maker, although somewhat changed in form.

Developmental Pueblo: this term was used by Morris several years prior to the first Pecos Conference and is now proposed again to supplant both Pueblo I and Pueblo II, incorporating them under the one heading. The complexities caused by the absence of one or the other in some sections and the difficulty of horizon determinations in others would thus be eliminated. It would indicate that the complex was in the evolutionary stages leading up to the maximum development.

Great Pueblo: an alternative title for Pueblo III in the original nomenclature, may be retained to designate the era which was truly the classic period of the Pueblos.

Regressive Pueblo: replacing the Pueblo IV, this name would denote the period in which there was a general recession from the preceding cultural peak.

Historic Pueblo: another choice proffered by the original tabulation, instead of Pueblo V."

[3] In the present resumé I omit reference to the cooking pottery, which was made at all times, but which changed less spectacularly from period to period. Its history is considered in a separate section, pp. 297-342.

long enough to see the Pecos pueblo grow to considerable size; but the ceramic art, as Mr. Amsden has pointed out, was in a sad state of degeneration.

Black-on-white was succeeded by two much finer wares, Biscuit and Glaze.[1] Biscuit constituted, at first, a fairly important element in the ceramic complex; but it soon declined in importance, persisting, however, as a minor ware nearly to the end of the Glaze period. Glaze, soon after its introduction, became the leading decorated pottery of Pecos. It seems firmly to have established itself by 1375, and it remained uninterruptedly in fashion until about 1700.[2] The three hundred or more years of the existence of Glaze at Pecos correspond very closely to the span of the Regressive Pueblo period.[3] During those centuries Pecos attained its greatest size and reached the peak of its cultural vigor. The same period saw the apogee of Pueblo life all through north-central New Mexico, a region which, during the Great Pueblo period, had been culturally backward in comparison to the San Juan, the Little Colorado, the Upper Gila, and the Mimbres. During the Regressive Pueblo period the local Glaze pottery passed through a series of sequent phases; Biscuit ultimately dropped entirely out of use; and, during the later years of Glaze, two undecorated non-culinary wares, Plain Red and Plain Black, came into service. Glaze degenerated and finally disappeared, being supplanted, at the end of the 17th Century, by the dull-paint Modern ware, which, with Plain Red and Plain Black, was in vogue during the last hundred and thirty years or so of the life of Pecos.

Glaze decorated pottery constitutes the most significant single category of Pecos ceramics. The period of its use covers, as I have said, the time of the village's greatest prosperity. It forms the best criterion not only for solving the problems of local archaeology, but for working out the whole later culture history of north-central New Mexico. Accurate knowledge of all varieties of the ware is accordingly

[1] The capitalized term "Glaze," used for convenience and brevity throughout this book, means "Glaze decorated." The application of glaze to the entire surface of a vessel was never practised by the Pueblos, even when, after the coming of the Spaniards, they must often have seen glazed pottery. There have been found a few very small pieces completely covered with glaze (Hewett, 1908, p. 83); these, however, seem to be the result of accidental spreading; the only deliberate use of glaze by the Pueblos was for the production of decorative patterns.

[2] All dates in this volume are tentative and subject to revision in the light of dendro-chronological studies now being made by W. S. Stallings of the Laboratory of Anthropology. Problems of chronology will be considered in the concluding section.

[3] Roberts (1929, p. 6) proposes, I believe with good reason, that the terminal date of this period (the Pueblo IV of the Pecos terminology) be extended from 1540 (the year of the discovery of the Southwest by Coronado) to 1700, when, at the close of the reconquest, modern conditions actually came into effect. The name Regressive Pueblo, while rightly indicative of conditions in the Pueblo area viewed as a whole, does not apply equally well to the Rio Grande, where during that period culture reached its greatest heights. As a matter of fact, the people of the Rio Grande were in a stage corresponding to late Developmental Pueblo (old Pueblo II) while the Great Period (Pueblo III, *ca.* 1050-1300 A.D.) was going on further west. The Rio Grande's Great Period opened about 1300, to last until shortly before the coming of the Spaniards. This well illustrates the fact that our investigation has now reached a point at which formal classifications such as the Pecos nomenclature are not only of lessening value, but are often, as in the present case, positively misleading. They are useful when our task is to reduce to order, and to bring meaning into, a mass of more or less disconnected archaeological data. But as archaeological findings group themselves to form a historical picture, systematic rigidities are better eschewed.

essential. This fact was to some extent realized even before work was started at Pecos, but once the excavations were under way it became increasingly obvious that their success must depend in large measure upon our ability to work out in detail the development of Glaze. Close attention was therefore naturally paid to the observation of this ware.

The methods employed in collecting material for the study of Pecos ceramics have already been described[1]; they resulted in the acquirement of the following categories of specimens: great numbers of selected sherds from the general digging; unselected lots of sherds from stratigraphic tests; selected series and unselected lots of sherds from pure deposits of various periods; and several hundred more or less complete vessels, mostly from graves.

Prior to the inauguration of the Pecos project I had proposed a tentative chronological ranking, based on technological and artistic grounds, of certain varieties of Rio Grande Glaze.[2] I classed as earliest a thin-rimmed, two-color Glaze which I then called "Agua Fria Schoolhouse ware"; I believed "Agua Fria" to have been succeeded by a polychrome[3] Glaze with light body-color, which I named "Frijolito," and I felt sure that a thick-rimmed polychrome Glaze with red body-color, generally known at that time as "Pajaritan", must be later than the other two.[4] The stratigraphic excavations at Pecos in 1915 confirmed these guesses, for "Agua Fria" lay at the bottom of the Glaze series in each test: pottery not unlike "Frijolito" occurred at a higher level; and above this were deposits containing "Pajaritan." Still above "Pajaritan," in the Pecos heaps, there appeared in great abundance a hitherto unfamiliar three-color type, with very heavy bowl-rims and decoration in dull red paint and black glaze upon a light slip. This I called in the field-notes "Pecos White."

Laboratory study of the ceramic material was not undertaken until the close of the second field season, in the autumn of 1916, by which time an enormous number of selected sherds and the product of some fifteen stratigraphic tests had become available. I already had, of course, a fairly good idea of the principal Glaze types and of their sequence, but my classification, being the result of field observation, was based on the general appearance of the specimens, on their "feel" and "look," rather than upon definite criteria. The obvious next step, therefore, was carefully to check the classification. This I did by going over the sherds from general digging

[1] Vol. I, pp. 8-11. [2] Kidder, 1915.

[3] The term "polychrome" is applied, in this paper, to wares whose ordinarily visible surfaces carry more than two colors. A bowl, for example, with red-slipped exterior, white-slipped interior, and black decoration, would be polychrome, a jar slipped red to the shoulder, white above, and decorated in black, would also be polychrome, as would a jar with lower part left in the natural paste, slipped in a contrasting color above the shoulder, and decorated with a pigment of a third color. But a jar whose exterior is covered with slip of a single color and whose decoration is also in a single color, would not be classed as polychrome, even though its interior should differ in color from its exterior.

[4] At the time that I was making these comparative studies, N. C. Nelson of the American Museum of Natural History was attacking the same problem on the much sounder basis of stratigraphy, a method which had not previously been used, save sporadically, in Southwestern archaeology (Nelson 1916). Nelson's work in the Galisteo Basin laid firm methodological foundations for all subsequent research in the Pueblo field. Its importance cannot be overstimated.

again and again, sorting them in various ways: by color, texture, nature of glaze, elements of decoration, and details of vessel shape. It soon became clear that of all these criteria the profile of the bowl and olla rims was the best. It was certainly the handiest, because it could be determined from very small or very badly worn sherds and could easily be recorded by drawings. It seemed also to be a reliable guide for preliminary groupings, because most pieces with a given rim-form tended to correspond to each other, and to differ from others, in color, glaze, and decoration.

At conclusion of the sorting I found myself with six Glaze groups: the four previously recognized, "Agua Fria," "Frijolito," "Pajaritan," "Pecos White"; and two others, one of which, because of its degenerate appearance and the resemblance of its rims to those of Modern dull-paint ware, I believed must be late. The sixth group was started as a sort of catch-all for unclassifiables; but, after throwing out a certain number of patently freakish pieces, it became evident that it constituted a true class, whose bowl rims and other attributes produced a strong impression that it should be placed between "Agua Fria" and "Frijolito." Temporarily I called it "X"-ware.

Up to this point I had purposely refrained from numbering the groups, because I did not wish to commit myself as to their sequential order until the material from the stratigraphic tests should have shown whether or not my classification had chronological significance. Accordingly, the sherds from each cut of each test were then sorted into the six above-mentioned groups and the results were plotted graphically, a process which proved beyond question that the field assignment of the four principal types had been correct; it also permitted the confident placing of "X"-ware between "Agua Fria" and "Frijolito" and the degenerate lot at the upper, or closing end of the series. Only at this stage of the investigation were numbers given to the types: "Agua Fria" being called Glaze I; "X"-ware, Glaze II; "Frijolito," Glaze III; "Pajaritan," Glaze IV; "Pecos White," Glaze V; the degenerate stuff, Glaze VI. Publication was made on this basis,[1] and the numerical terms have been employed in all subsequent field notes and reports of the Pecos Expedition.

The division of the Glaze ware of Pecos into six chronologically sequent types is a very convenient and, superficially, satisfactory arrangement. For some time I was very proud of it, so much so, in fact, that I came to think and to write about the types as if they were definite and describable entities. They are, of course, nothing of the sort, being merely useful cross-sections of a constantly changing cultural trait. Most types, in reality, grew one from the other by stages well-nigh imperceptible. My grouping therefore amounts to a selection of six recognizable nodes of individuality; and a forcing into association with the most strongly marked or "peak" material of many actually older and younger transitional specimens. Such, at least, is my present opinion, for, as will be brought out in discussion of the types, I can see no evidence that there were any abrupt mutations during the long career of Pecos Glaze. This pottery did not stand still; through some three centuries it underwent a slow, usually subtle, but never-ceasing metamorphosis. Record of its life is of course the aim of the present study. The story should be in narrative form, and such an account must eventually be written. But, to gain sufficient information to permit a

[1] Kidder, M. A. and A. V., 1917.

running account, one must transect here and there, not only to study trends, but in order to present, by way of evidence and for the practical purposes of field archaeology, still-pictures, so to speak, of the material at a series of points.

In the first part of this volume I treat what may be called the gross aspects of the pottery found at Pecos: vessel-form, surface color, decoration. The second part concerns the technological characteristics of the wares. It is by Miss Anna O. Shepard, of the Laboratory of Anthropology at Santa Fe, who, by courtesy of Director J. L. Nusbaum, has been permitted to undertake the studies of clays, tempering materials, slips, and pigments the results of which constitute Part II of this report. Miss Shepard's contribution opens up a field of ceramic research which has long been recognized as important, but which has to date remained relatively little developed. That the technological investigation constitutes a very real advance becomes clear if one understands the peculiar rôle which pottery has played in Southwestern archaeology.

When pueblo ruins first came under investigation, pottery was considered as merely one among many manifestations of culture. The needs of the students of that time were therefore adequately served by broad classifications, based upon the most obvious attributes. Only perfect specimens were sought; few, if any, sherds were brought in by expeditions, nor were they so much as mentioned in the majority of the earlier reports. Even when a closer focussing of interest upon pottery led to the undertaking of morphological and developmental studies, there was no immediate need for consideration of sherds, nor for going below the surface of the whole vessels. But eventually it was found that such studies not only required more evidence than was provided by complete pieces, but that chronological relationships must also be more clearly understood. The desired increase in bulk of material could only be brought about by the gathering of the hitherto neglected fragments; and time factors could most satisfactorily be gauged by stratigraphic excavation. Both these activities forced field archaeologists to turn their attention from graves and buildings, which produced limited numbers of whole pots, to rubbish heaps and middens, which yielded great quantities of sherds, and which also offered the best opportunity for recovery of stratigraphic data.

Classifications of greater refinement now became possible; ceramic periods began to be recognized. Concurrently, there was a natural growth of interest in the geographical range of the newly established types and in their chronological interrelation. These problems can most cheaply and quickly be attacked by means of the surface sherd survey, a process which gives information as to the typical wares of any given site and, by the cross-ties provided by traded materials, as to its date relative to other ruins. The surface survey, like stratigraphic excavation, results in accumulation of enormous numbers of fragments.

From the foregoing it will readily be grasped that the Southwestern archaeologist nowadays deals with sherds far more than with complete vessels. His observations, accordingly, must not only be refined, but his deductions must also be based, to a certain extent, upon new categories of evidence. Vessel shape, for example, can seldom be determined with accuracy from sherds; and therefore the shapes of parts of vessels, such as rims and bottoms, become elements of importance. Decoration,

likewise, often eludes restoration from small fragments; and study of design gives way to consideration of styles of painting and color combinations. Use of these more subtle criteria has forced students of Southwestern ceramics to place increasing reliance upon the "feel" and the "look" of wares. Such qualities are doubtless of value, particularly to persons gifted with an acute pottery sense; they are, however, matters of individual and, to a considerable degree, subjective perception. Moreover, they cannot adequately be expressed in words or even, as a rule, by the best of illustrations; so that conclusions drawn from them must be taken by other workers largely on faith. Hence the very general desire of Southwesternists, most recently voiced by Hargrave,[1] for the establishment of additional criteria for pottery classification, criteria which shall be applicable to fragmentary material, which shall be objective, measurable, and above all recordable. The late Wesley Bradfield was the first clearly to sense this need. It was he, indeed, who encouraged Miss Shepard to undertake technological research.

The requisite new criteria can probably best be derived from the technological properties of the wares; and Miss Shepard's work is an attempt to gauge the possibilities of technological research as an aid to archaeology. Her results speak for themselves. She has, it is true, been concerned with the pottery of a single site. But the variety and definiteness of the ceramic attributes which she has been able to recognize and describe, indicate that similar methods will be widely applicable. Technological study gives us precise classificational criteria which provide a means for distinguishing local from non-local ingredients. Imported wares can thus confidently be identified as such; and their exact provenience may often be determined. Our understanding of primitive ceramic processes will be vastly extended. Research of this type brings into Southwestern archaeology an element of honest accuracy of which it has long been sorely in need.

It is obvious that technological observations require specialized training. The same, of course, is true of the tree-ring readings involved in dendrochronology. Both activities will have to be carried on by specialists. But it is probable that there can be isolated certain significant technological features which anyone can recognize and use. However, like all innovations which serve to complicate a science, ceramic technology will prove distasteful to some who find it beyond their ability personally to practise; as well as to others whose preconceived opinions it serves to contravert. On the other hand, there is danger that its satisfactory accuracy may lead others to swing to the extreme of depending entirely upon the microscope and the test tube, neglecting all older and less precise methods of evaluation. This tendency, however, can be counteracted by remembering, as archaeologists must always do, that the objects they excavate are the handiwork of man, and that to their lifeless substance human beings have added something which no lens can reveal nor any chemical precipitate.

Technological details are interesting in themselves, but they must have historical significance to justify the time required to work them out. And historical significance the technological studies of Pecos pottery most certainly have. Miss Shep-

[1] 1932, p. 9.

ard's findings, indeed, have raised serious problems regarding the interpretation of the Pecos pottery. Two years ago I had written, for inclusion in the present volume, a discussion of the development of the local decorative art based on the supposition that all the pottery found at Pecos, with the exception of a few patently imported pieces, had been made there. I realized, of course, that certain artistic stimuli had come from exterior sources; but I believed that in general the ceramic history of the pueblo could be worked out, so to speak, on the ground. But Miss Shepard has now demonstrated that several very important types of pottery contain ingredients which could not possibly have been procured in the valley. It is her opinion that the thousands of vessels concerned were brought to the pueblo in manufactured form.

If this was actually the case, we are faced by the necessity for a drastic rearrangement of ideas regarding the status of the ceramic industry, not only at Pecos, but throughout the Southwest. It has always been assumed that potting was one of the regular household tasks of every Pueblo woman; that each town was in this regard self-sufficient. But if whole classes of pottery, such as Glaze I and Biscuit, were imported, we must postulate an extraordinary volume of trade and allow for a compensating outward flow of other commodities. Furthermore, we must believe that the production of vessels at the source of supply was much greater than was needed for home consumption, in other words, that rudimentary commercial manufacturing was practised. And if this took place in the Rio Grande it may have occurred in other areas. There are, indeed, some indications to that effect. It has always for example, been hard to account for the remarkable homogeneity of certain wares, e.g. Mesa Verde Black-on-white, Mimbres Black-on-white, Sikyatki Polychrome. These conditions might be explained by mass-production, as it were, in a few centres. And, as far as Pecos is concerned, such a postulate would solve the puzzling problem of the sudden appearance of entirely new types, e.g. Glaze I, and Modern painted (Tewa Polychrome).

Pecos may, of course, have been unique in importing much of its pottery. It was a peripheral town. It is possible that its nearness to the Plains resulted in the loss of the supposedly characteristic Pueblo custom of exclusive home manufacture of vessels. Taos, similarly situated, and further un-Pueblo in lacking a clan system, has apparently been without a ceramic industry for a long time. Perhaps buffalo products—hides, sinew, dried meat—served the Pecos as a medium of exchange.

If the groups of pottery in question were made locally of foreign materials difficult questions would still have to be faced. Why, for instance, should rock from the Galisteo Basin and tuff from the Pajarito be secured at the cost of long journeys, when substances equally as good were to be found immediately at hand? The most plausible explanation would be that people from those regions had settled at Pecos and, firmly wedded to old customs, had returned to their former ranges to acquire ingredients considered indispensable. Or the introduction of a style might have involved such slavish copying of the prototype as to require use of identical materials.

Enough has been said to show what a bombshell Miss Shepard's findings have thrown into the research; and it will be obvious how disastrously they have wrecked the complacent conclusions I was on the point of issuing. As a matter of fact, because of the wider horizons opened by the technological study, and the resultant need for

greater knowledge of the ceramic situation in other areas, one can hardly draw conclusions at all. But many new problems have been formulated and it is also possible to indicate lines of research which should lead to their solution.

In an earlier paragraph it was stated that the surface sherd survey is at present being widely employed. This method of acquiring data upon the distribution of pottery types did not come into general use in the Southwest until about 1910. Beginning in that year Guernsey and the writer built up at the Peabody Museum what we then called a "library of sherds" from northeastern Arizona and from the country about Santa Fe. At the same time Nelson was excavating in the Galisteo Basin and acquiring information for historical interpretation of his stratigraphic results by collecting sherds from ruins in the Galisteo and adjacent regions. In 1915 Kroeber began and in 1916 Spier completed the first really thorough and comprehensive undertaking of this sort, a conspectus of the archaeological sites of the Zuñi district. Their work, of which stratigraphic testing of rubbish mounds was an integral part, first clearly demonstrated the great value of the intelligent gathering, laboratory study, and statistical treatment of surface materials.[1]

After the War there opened a period of intensive excavation at large sites: Pueblo Bonito was cleared by Judd under the auspices of the National Geographic Society; Hodge worked at Hawikuh for the Museum of the American Indian; Phillips Academy's investigations at Pecos were carried forward. These and other similar investigations focused the attention of the men in charge upon local rather than upon general or even regional problems, and the sherd survey fell into disuse save for a reconnaissance of the San Juan and parts of the Little Colorado drainages made by the writer in 1923 as part of the preparation of the "Introduction" (No. I of the present series).

Toward the end of the 1920's need began to be felt for determination of the ranges of the many types of pottery which had come to light during the above-mentioned excavations. This led to a recrudescence of surveying, the most active agencies being the Museum of Northern Arizona, working principally in the San Francisco Mountain and Hopi regions; the Laboratory of Anthropology, operating in the Upper Rio Grande; and Gila Pueblo, which is covering the entire Southwestern field. Sherds from something like 12,000 sites are at present housed in these three institutions.

Even before sherd surveying was taken up so vigorously, the need had been felt for a uniform nomenclature of pottery types. The flood of new material coming in from the surveys rendered it increasingly essential. From the early days of Southwestern archaeology descriptive terms for decorated wares had been in use, e.g., "Black-on-white," "Black-on-red." As regional differences became apparent, there developed a tendency to apply such geographical names as "Mesa Verde," "Chaco Canyon," "Pajaritan." Still later, when it was seen that local complexes often contained more than one decorated ware, a sort of binomial system was more or less haphazardly employed. In 1924, for example, I call certain Hopi pottery "Jeddito Yellow," but in the same publication I referred to another Hopi ware as "Sikyatki,"

[1] Kroeber, 1916; Spier, 1917.

without a descriptive qualifier.[1] At the Pecos Conference of 1927 the matter of names was discussed and general agreement was reached that those present should "consider the advisability of a binomial ware-nomenclature; the first name to be indicative of the locality of highest development, the second a technically descriptive term; for example, Sikyatki yellow, Mimbres black-on-white, Upper Rio Grande incised, etc."[2] The question came up again at the Pecos Conference of 1929; and at the Globe Conference of 1930 the binomial system was definitely adopted. There was also formulated a series of recommendations for the naming and description of types and for the preservation of type-specimens.[3] The method has generally been followed.

The most recent contribution to nomenclature is the paper by Hargrave on the Hopi and San Francisco mountain regions, in which forty pottery types are grouped by "orders," "wares", and "genera".[4] This is not the place to discuss the very questionable desirability of so close a patterning of archaeological upon biological taxonomy, nor to argue that it is much too early in the game to determine with any assurance the genetic relationships implied by Hargrave's assemblages.[5] It is evident, however, that binomial designation is a practical and convenient method for the labelling of typological units.

The new system was designed to bring order into the rather chaotic situation obtaining in earlier ceramic literature. But it has resulted in a taxonomic debauch. Colton and Hargrave, who are at the moment striving to straighten out the present tangle by preparing a check-list, presumably know how many types have been named during the past five years. Certainly no one else does, for the count must run into the hundreds. Such a multiplication, which is comparable to what was brought about in biology when the "splitters" were in the saddle, has been greatly deplored by non-Southwesternists, particularly by teachers of archaeology, who find themselves unable to interpret the highly specialized current literature in terms of Southwestern history for the benefit of their students. There has been, as Roberts shows in his recent excellent summary of conditions in Southwestern archaeology, a great deal of "viewing with alarm."[6] But things, on the whole, are really not as bad as they

[1] Kidder, 1924, p. 93. I have emphasized my own connection with sherd surveying and the development of the nomenclature of Southwestern pottery in order that what follows shall not be construed as indicating fundamental disbelief in the value of surface collecting or of a systematic terminology.

[2] Kidder, 1927, p. 490. [3] Gladwin, W. and H. S., 1930, a.

[4] Hargrave, 1932. See also Hargrave and Colton, 1935, for a statement of taxonomic usage recommended by the Museum of Northern Arizona.

[5] A ceramic or other cultural category, a group of the sort we are accustomed to call a type, is not an entity comparable to a biological species. Species, in the animate world, are kept pure by the infertility of hybrids. The laws of cultural genetics impose different and less tangible, though perhaps no less stringent, limitations. These laws cannot yet be formulated. The whole study of anthropology is, indeed, an attempt to discern their nature through observation of their operation. But certain things we already know: cultural crosses, far from producing sterility, often result in markedly increased virility; cultural parentage is not achieved by simple pair-mating, but may be the result of anything from parthenogenesis to the simultaneous or continuing interaction of many strains, each entering into the blend to a different degree. A most illuminating discussion of the similarities and differences between organic and cultural evolution has been presented by Kroeber (1931).

[6] Roberts, 1935.

seem to many outsiders. Our adolescent discipline (I do not venture to call it a science) is merely suffering from growing pains; it is having its ceramic measles. The study is extraordinarily complex, materials are abundant, workers many, judgments diverse. Temporary confusion is inevitable. But sound classifications and valid deductions eventually will emerge. And in justice to the surveyors and namers it should be stated that they have never allowed themselves to lose sight of the historical implications of their work, as witness the Gladwins' most suggestive chart covering almost the entire Southwest, Mera's essay on Rio Grande origins, and Colton and Hargrave's reconstruction of events in the San Francisco Mountain region.[1] In certain ways, however, the methodology of all these investigators is open to serious criticism.

In the first place, they have elevated one of the minor techniques of archaeological field practice to a position of undue importance. The survey is at best no more than a cheap and quick substitute for excavation. It is useful for preliminary reconnaissance of little-known areas in order to estimate the general situation and to locate key sites for intensive examination. Secondly, when excavation of such sites has been carried out, surveying may again be undertaken with profit for the purpose of ascertaining the distribution of the types which have been identified and described as result of the digging, and which have been ranked chronologically by stratigraphy.

Ceramic types, however, cannot satisfactorily be established on the basis of surface sherds, because these are almost always so small as to prevent proper study of vessel shape and particularly of design; and also because one can never be certain that groups of specimens from above-ground constitute unmixed chronological samples. Hence no final determinations, either typological or developmental, should be made from survey material alone. The surveyors will, of course, aver that they are not making final determinations and that their conclusions are merely working hypotheses. But great numbers of types have recently been named after superficial examination of meagre lots of fragments; and the legitimate use of the hypothesis has habitually been exceeded by the logically unpermissible founding of further hypotheses upon theories untested by excavation.

An equally serious fault of much recent work is failure to publish adequate descriptions of types. The rules established at the Globe Conference expressly provide that types should be described in detail[2]; Colton and Hargrave, in setting forth the "Rules of Priority" being used in the compilation of their forthcoming Handbook, postulate that, "the type must be sufficiently well described that the description does not conflict with the published description of another type."[3] Yet these requirements have practically never been fulfilled, as can be proved by the most cursory examination of present-day literature. Sins of omission have preponderated: one author stresses color and megascopic observations upon paste and temper, but ignores decoration; another presents excellent color plates of selected pieces, but condenses verbal description to the vanishing point; a third relies on photographs of

[1] Gladwin, W. and H. S., 1935; Mera, 1935; Colton and Hargrave in *Bulletins* and *Museum Notes* of the Museum of Northern Arizona.

[2] Gladwin, W. and H. S., 1930, a. [3] Hargrave and Colton, 1935.

a half-handful of sherds to record differences between types which he names and upon which he bases the most far-reaching conclusions. These gentlemen are undoubtedly correct in feeling that pottery types are definable and that such types should be used as basis for classificational and genetic determinations. They have not, however, been willing to excavate larger and more abundant sherds than can usually be found on the surface; nor to undertake meticulous studies of vessel-shape, paste, and decoration. And only adequate material laborously examined can yield valid typological results.

Undue haste to arrive at the stage of synthesis is largely to blame. There has also, I suspect, been an unfortunate, though quite human, desire for priority. Each investigator has wished to have the pet terms he has been accustomed to use legitimized by publication. It is also irksome to have another man skim the taxonomic cream from one's bowl. For this reason I cannot too strongly deplore Hargrave's attempt to introduce the biological practice of bracketting, after the type appellation, the name of the accepted sponsor. His desire, of course, was to simplify reference. But if, as has been the case in biology, it becomes a matter of credit to name types, the door will be open for all sort of rivalries, disputes as to priority, half-cock terminology, "splitting." We have opportunity to plan our work intelligently, avoiding the mistakes and profiting by the successes of other disciplines.

Were it necessary for us to complete our study of Southwestern history in a limited time; or were there no possibility of acquiring excavated materials, the surface survey would of course become the principal method of research, and those qualities best observable in surface sherds would assume outstanding significance. But we are under no pressure, save that exercised upon individuals by the shortness of human life; and pottery in endless amounts can almost always be turned up by a little shovelling. There can therefore be no excuse for the hasty erection of theoretical structures upon foundations of half-baked typological bricks. It is natural enough to desire concrete returns from our labor. Historical synthesis is our ultimate goal. Over-preoccupation with minutiae brings danger of narrowing one's outlook to the point of futility. And while there is truth in the old saying about the forest and the trees, that maxim, it should be noted, refers to seeing the woods but not to understanding how and why they grow. We must realize that archaeology cannot be done in a hurry; that the reading of the fragmentary record of the past cannot be other than a long and arduous task; and that if it is worth doing at all it is essential that it be done as well as possible.

To return to the matter of type description. Hargrave has performed a signal service in listing the qualities which should be taken into account in setting up a new type.[1] He emphasizes technological characteristics, because decorative features cannot be studied to advantage from the generally small and often badly weathered sherds found on the surface of sites. But larger sherds, to say nothing of whole vessels, are, as has been said, to be got by digging; and careful work yields surprisingly full information as to design, even from very fragmentary material. And I believe decoration to be the single most valuable criterion for the classification of

[1] Hargrave, 1932, p. 9.

Southwestern pottery, as well as for tracing the descent of types and for establishing collateral relationships. Whole compositions, and perhaps to an even greater degree the elements which are combined to form them, contain a wealth of information for solving the difficult problems of Southwestern pottery. It is in the embellishment of vessels that ceramic styles are most emphatically expressed. Decoration was one of the main preoccupations of the potter. Bunzel's work at Zuñi and Acoma makes this very clear.[1] And as our research deals with an individual rather than a factory product, those elements which were of importance to the craftworker herself are of correspondingly great significance for unravelling the history of her craft.

It is to be doubted that Southwestern potters gave very great thought to the ingredients that went into their product. Once the potter's art had become firmly established in the Modified Basket Maker period there were apparently no further radical changes in the fundamental processes involved in turning our vessels. Mixing of clay and temper, moulding, decorating, firing are practised among the Pueblos of today essentially as they were a thousand years ago. The differences which give identity to the multifarious types produced in the long course of Southwestern history have been brought about by variations in the superficial characteristics of wares—in vessel shape, slip color, paint, and particularly in decoration—rather than by intentional modifications in the unseen and, if it satisfied a few essential and customary requirements, the probably more or less unregarded paste. Hence such technological features as combinations of clays and tempering materials are of secondary moment to the archaeologist, as they doubtless were also to the potter. To raise them to the rank of primary classificational criteria, as Hargrave has done,[2] is not only unsound logically, but results in groupings which, if one also employs biological terminology with its inherent implications of genetic relationship, are positively misleading. For example, his system applied to the Pecos materials, would place Glaze I and II in distinct Orders, because the one is tempered with rock, the other with sand; Glaze I Red and Glaze I Yellow, which are so closely related that in a biological classification they could be no more than subspecies, would, on the basis of their differing slip colors, be assigned to separate Families. On the other hand, types widely separated in time, and presumably also of entirely unlike cultural antecedents, would find themselves in the same Genus.

A further reason for objecting to the use of paste for major groupings is that working classifications of archaeological materials should be made by the archaeologist, for he, rather than the technologist, is conversant with the cultural and historical problems toward the ultimate solution of which all taxonomic arrangements are a preliminary step. But the general archaeologist is not competent to carry out the detailed and highly specialized studies essential for accurate determinations of the makeup of pastes, nor does he have sufficient knowledge to gauge the effects, upon similar ingredients, of different firing temperatures and kiln atmospheres. A little learning is, in ceramics, a very dangerous thing. Megascopic observation, as Miss Shepard brings out in her section of this book, cannot be depended upon for

[1] Bunzel, 1929. [2] Hargrave, 1932, p. 8.

identification of clays, tempers, or pigments. And inaccurate determinations are worse than useless. Until such time, therefore, as the technologists shall have isolated significant technological characters and have worked out methods for their recognition, measurement, and recording which can safely be used by persons untrained in laboratory technique, archaeologists should confine themselves to observation of the surface features of pottery.

The above must not for a moment be construed as indicating disbelief in the value of ceramic technology, which has a significant, indeed an essential, rôle to play in archaeological research. Its proper place in the study of pottery is fully explained by Miss Shepard in the introduction to Part Two; and its application to specific problems is strikingly illustrated by the results of her investigation of the Pecos wares.

Before proceeding to description of the pottery from Pecos, it is necessary to say a word regarding nomenclature. Binomial designations of pottery types are now generally employed. I have therefore naturally wished to adopt that usage. Yet for the purposes of this book, it did not seem wise to do so. In treating the Glaze types, for instance, I could have conformed to established practice only by sacrificing the numbers I, II, III, etc., because the Globe Conference expressly, and very sensibly, discouraged recognition, in nomenclature, of time factors. But the numbers so clearly and conveniently express the chronological relationships of the Pecos material that I was most loath to give them up. An even worse difficulty would have arisen had I permitted myself to assign to each type a name. The Globe system calls for a specific geographical term which, though it need not necessarily designate the spot where the type was first found or its area of greatest density, should nevertheless, it seems to me, be reasonably indicative of some nuclear locality. But my knowledge of the general ceramic situation in the Rio Grande was not sufficient to identify such nuclei. Furthermore, I did not wish to fix in the literature names for more or less arbitrarily delimited chronological subdivisions of material from a single site, in face of the obvious possibility that such subdivisions would not prove valid for the region as a whole.

The difficulty has happily been solved by the appearance of Mera's paper upon the Rio Grande Glazes, in which, on the basis of a surface sherd survey of the entire area, he has gathered all recognizable types into six sequent lettered groups (thereby avoiding confusion with the Pecos numbers), and has applied to each type and subtype a binomial designation.[1] There is thus provided a general nomenclature by means of which Pecos pottery can be related to and integrated with Rio Grande ceramics in general. And I am also relieved of the fear that the numbered Pecos types might, because of their elaborate description in this book, come to be considered characteristic of all Rio Grande ruins, thereby bringing about too early a crystallization of opinion regarding a ceramic situation much more involved than exists at Pecos or any other single pueblo. It is accordingly possible to continue, with a clear conscience, the very handy and expressive use of numbers. In the text each type is provisionally identified with one of Mera's named types. The following

[1] Mera, 1933.

table makes clear the interlocking of the Mera and Pecos terminologies; it also lists the names which Mera (1935) has applied to certain Black-on-white types which were described by Amsden in the first volume of this report. Miss Shepard and I have decided to retain, in the present text, all but one of the original Amsden names, in order to preserve uniformity of nomenclature in the two volumes, and also because Mera's types may not prove to be exactly identical with those from Pecos. In the same table I have, in order to conform to binomial practice, suggested new terms for the two Biscuit wares.

Mera (1933)	Pecos
Group A	Glaze I
Agua Fria Glaze-on-red	Glaze I Red
Arenal Glaze-polychrome	Very rare (see p. 363)
San Clemente Glaze-polychrome	Very rare (see p. 69)
Cieneguilla Glaze-on-yellow	Glaze I Yellow
Group B	Glaze II
Largo Glaze-on-yellow	Glaze II
Largo Glaze-polychrome	Glaze II with red ext. dec.
Group C	Glazes II-III
Espinoso Glaze-polychrome	Late Glaze II to early Glaze III
Group D	Glazes III-IV
San Lazaro Glaze-polychrome	Glazes III and IV
Group E	Late Glaze IV and Glaze V
Puaray Glaze-polychrome	Absent
Pecos Glaze-polychrome	Glaze V
Trenaquel Glaze-polychrome	Absent
Group F	Glaze VI
Kotyiti Glaze-polychrome or Glaze-on-red	Glaze VI
Cicuye Glaze-polychrome or Glaze-on-red	Minor variant of Glaze VI

Mera (1935)	Pecos Valley (Amsden, Vol. I)
Santa Fe Black-on-white	Blue-gray Black-on-white
Galisteo Black-on-white	Crackle Black-on-white
Wiyo Black-on-white	Biscuitoid, Clay

New designations	Old designations
Rowe Black-on-white	Late Crackle Black-on-white
Abiquiu Black-on-gray	Biscuit A
Bandelier Black-on-gray	Biscuit B

The drawings of designs are by Mrs. Chadwick. They are, as nearly as possible, exact copies, preserving all irregularities of line, "runs" of the glaze, and mistakes of the decorator. Missing parts of designs are indicated by broken lines. Where small sherds are lacking, or where a lost fragment obviously bore a repetition of an element seen on another part of the vessel, the design has been restored in order to render the illustrations as clearly comprehensible as possible, but this was never

done where any reasonable doubt existed. A list of the catalogue numbers of all specimens figured is on file at Andover, so that should question arise regarding the accuracy of any reproduction, the original piece may be consulted. Throughout the illustrations, red pigment is represented by hachure, except as otherwise noted.

During the reading of the proof it has been found that I have spelled Tsia differently from Miss Shepard, who writes this name Zia.

PART ONE

GLAZE, UNDECORATED SMOOTH, CULINARY, AND TRADE WARES

THE GLAZES

GLAZE I RED[1]

Glaze I, as is implied by its designation, was the first glaze decorated ware to become a major element in the Pecos ceramic complex. Previous to its rise Glaze vessels were, it is true, in limited use at the pueblo[2]; a glaze-like paint, indeed, was not unknown at the still older Forked Lightning village.[3] But, as will be shown, these earlier Glazes were almost certainly not of local or even of regional manufacture; nor, presumably, were they directly ancestral to Pecos Glaze I. The vexed question of the origin of the latter type will be considered in another section. Here it suffices to say that Glaze I made its appearance suddenly and in fully perfected form, inaugurating the long career of glaze decorated ware at Pecos, a career which was actually an unbroken development, but which, as was stated in the Introduction, has for convenience of description arbitrarily been divided into a series of sequent periods, each one characterized by a type of pottery different from that which came before and that which followed after.

Glaze I was first recognized as a distinct type in 1911. During that year Mrs. Kidder and I found, at a ruin in the village of Agua Fria,[4] near Santa Fe, glaze decorated sherds which were unlike the Glazes of the large sites on the Pajarito Plateau. We called them "Agua Fria Schoolhouse"; a short description appeared in 1915.[5] We inferred, from their occurrence at a relatively small site, from their association there with Black-on-white pottery, and from their geometric decoration, that they were early. This guess was soon confirmed by Nelson's excavations in the pueblos of the Galisteo Basin. His stratigraphic tests proved conclusively that this was the first of the native Rio Grande Glazes. He very sensibly repudiated the cumbersome name, "Agua Fria Schoolhouse," and published a description in which he grouped it with some forms of what I subsequently classed as Glaze II in his category of "Two-color Glazed Wares."[6] When, however, the material from the tests at Pecos was studied, it became evident that there were significant differences between the various elements of the two-color category. Nelson's nomenclature was, therefore, refined, Glaze I was separated from Glaze II, and Glaze I itself was

[1] Comparable to Mera's "Agua Fria Glaze-on-red."
[2] Heshotauthla Polychrome; see p. 363.
[3] A variety of St. Johns Polychrome; see p. 362.
[4] Ruin No. 2 of the Laboratory of Anthropology survey.
[5] Kidder, 1915, p. 448. [6] Nelson, 1916, p. 172.

divided into Red and Yellow phases.[1] The latest contribution is the paper in which Mera names material comparable to Pecos Glaze I Red, "Agua Fria Glaze-on-red"; that comparable to Pecos Glaze I Yellow, "Cieneguilla Glaze-on-yellow or polychrome." These two types, with two variants, "Arenal Glaze-polychrome" and "San Clemente Glaze-polychrome," he places in his Group A.[2]

Glaze I Red and Glaze I Yellow are here described separately, for though they are closely similar in technology and in decoration, they had different careers. Red passed out of use; Yellow persisted, ultimately giving rise to Glaze II. During the preparation of this book evidence came to light which made it seem desirable also to isolate a small group of material representing the latest Glaze I Red. This has been called Glaze I Red, Local Type. Its description follows that of Glaze I Yellow.

At the beginning of the Glaze I period, Red predominated very strongly over Yellow. During a short time, indeed, I believe that it held the field alone, for the lowest strata of the large Glaze I rubbish bed on the North Terrace yielded no Yellow at all. Nelson's San Cristobal midden showed a like condition.[3] The Yellow phase, however, very soon put in an appearance. In most early Glaze deposits it ranges from only 2 or 3 to a maximum of not more than 10%. It did not reach parity with Red until a little more than half-way through the Glaze I period. Thereafter Yellow went definitely into the lead, and by the opening of the Glaze II period, Red had declined heavily in relative abundance. The best time for both wares, the heyday, so to speak, of Glaze I, was when Red stood at about 70% and Yellow at about 30%. The sherds, both Red and Yellow, from any deposit or stratigraphic cut showing these approximate proportions are somewhat finer in color and decoration than those from older layers; and they are distinctly superior to material from the subsequent horizons in which Yellow preponderates.

General Characteristics[4]

Two-color: decoration in black glaze on a dark red background.[5] The red slips are in the darker range or shades[6] of red-orange or orange-red mixtures. Although no

[1] Kidder, M. A. and A. V., 1917. This and the above-quoted descriptions (Kidder, 1915; Nelson, 1916), together with a paper by Mera (1933), constitute the only published material upon Glaze I. Nelson's collections from the Galisteo Basin and nearby sites are in the American Museum of Natural History, New York; the Pecos specimens are at Andover and in the Museum of New Mexico, Santa Fe; extensive sherd collections have been made by H. P. Mera for the Laboratory of Anthropology, Santa Fe; a small but fine lot, excavated by E. H. Morris from sites near Santa Fe, is in the University of Colorado Museum at Boulder.

[2] Mera, 1933.

[3] Nelson, 1916, p. 166, Stratum 9.

[4] Miss Shepard's technological description of Glaze I Red will be found on pp. 498-501.

[5] The Ridgway (1912) standards are used throughout this volume to describe specific colors. Ridgeway color-names are capitalized and followed by their serial designations in brackets; the names of colors used in a more general sense are not capitalized, e.g., "This is a red ware, the slip is normally Hay's Russet (7'k.)." The slip colors (Ridgway) of the various types are included in Miss Shepard's technological descriptions.

[6] A shade, according to Ridgway (1912, pp. 16, 17) is "any color (pure or broken) darkened by shadow or (in the case of pigments) by admixture of black; exactly the opposite of *tint;* as, a medium, dark, or very dark (dusky) *shade* of red. A tint is any color weakened by high illumination or (in the case of pigments) by admixture of white; as, a deep, medium, light, pale or delicate (pallid) *tint* of red."

two pieces are of exactly the same color, the general effect of a number of bowls or fragments laid out together and viewed *en masse* is one of uniformity. It is also very agreeable, for the color is rich, and the black decoration contrasts pleasantly and quietly with the red surface upon which it is applied. Dark firing clouds are often present, but as their edges fade through the browns into the normal red, they do not constitute a serious blemish. Glaze I Red is, to me, the most satisfying type of Pecos pottery, with the possible exception of Glaze IV.

The slip is very thin, so light a coat, indeed, that it cannot be distinguished, in section, even with the aid of a hand-glass. I have accordingly sometimes wondered if it might not be a well-smoothed unslipped surface. But Miss Shepard presents good evidence that a slip was actually applied (see p. 72). At all events, the slip amalgamates so well with the paste that it never flakes, and very rarely "crackles," which means, I presume, that it must have almost identically the same physical properties as the paste. Minute, shiny particles are sometimes to be seen in the slip, but much more rarely than, and never so thickly sown as in, Glaze I Red, Local Type (see p. 72). The finish is normally admirably smooth, but never glossy. Marks of the rubbing stone are seldom seen.

Bowls were obviously fired in the inverted position, for fire-clouds only occur on their exteriors. The clouds are black, often slightly yellowish or whitish at their centres; at the edges they shade off through gray to brown.

The glaze is always an attractive and, at its best, a very beautiful substance. In common with all the Rio Grande glazes, it does not sink into the slip, but rather lies upon it, so that a finger rubbed lightly across the lines can sense the difference in elevation. This, however, is the thinnest and flattest of all. It fired exactly as applied without spreading or running. Its color is jet black where heavy, brownish where brushed out thin. It surface is marked by many almost microscopic blisters which give it a slightly "slaggy" effect. Where it is particularly heavily applied it often draws together into very characteristic little flat beads.[1] The luster varies considerably, often on the same vessel, some lines being brilliant, others duller (producing a "varnishy" effect); still others are entirely dull. Even where there is no luster at all, its thickness, and the fact that it stands out on the slip in low relief prevents confusion between it and the various dull paints.

One point remains to be considered—crusting of the glaze. Many vessels and sherds have a whitish deposit adhering to them, particularly along the lines of the glaze paint. Some of this is lime accumulated after burial, which can be removed by immersion in hydrochloric acid: no amount of acid, nor the most diligent scrubbing, however, will eliminate from the glaze some forms of white crust. This substance does not occur on the slip, but appears to be thoroughly amalgamated with the vitreous body of the glaze, it is possibly the result of some native impurity baked in during the original firing. It occurs to a greater or less extent on glaze of all periods.

[1] "Beading" of the glaze would seem to be due to some chemical, or perhaps physical, quality of the red surface underlying it, for it never appears upon the contemporaneous Glaze I Yellow, or even upon later red types.

VESSEL SHAPES

Glaze I Red appears, at Pecos, in but two forms: bowls and ollas. I have never seen even a sherd of a ladle, mug, cup, canteen, pitcher, or of any eccentrically shaped vessel.

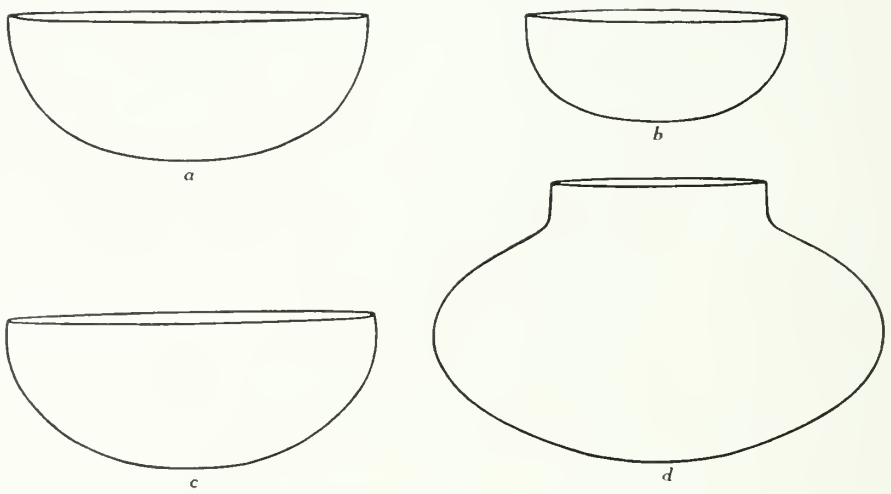


Fig. 1. Glaze I Red. Vessel shapes. *a*, *c:* Large bowls. *b:* Small bowl. *d:* Olla. (1/6)

BOWLS

There are two sorts of bowls: the large and the small, large bowls being by far the more common.

LARGE BOWLS are remarkable for trueness of moulding and uniformity of dimensions. In both these qualities they are in striking contrast to the ill-shaped and variably sized Black-on-white bowls which preceded them chronologically at this pueblo. As the outline drawings and the photographs show (figs. 1, *a*, *c;* 3; 4, *a*, *b*), they are evenly rounded from rim to rim, there being no flattening at the bottom. The point of greatest diameter is at or a trifle below the lip. The *rim* is "direct," that is to say, the body wall rises to the lip with neither flare nor constriction, thickening or thinning.[1] The *lip* is gently rounded (fig. 2, *a-c*), flattish with rounded corners (*d-f*), often truly flat (*g-i*). The bowls are extraordinarily uniform in *size*. In the forty-odd examples sufficiently complete for accurate measurement, there is a variation in diameter of only 2½ inches, the smallest being 10¾ inches across, the largest 13¼. The majority are between 11½ and 12½ inches; the average of the lot is 11⅞ inches. In depth the uniformity is equally striking, extremes being

[1] The term "rim" is used to describe that part of a vessel which adjoins the orifice. The "lip" is the terminal edge of the rim.

4¼ and 5⅜ inches, the average 4¾. The average *orifice-depth index*[1] is very close to .40; the shallowest bowl, relative to its width at the lip, is .37, the deepest .44. The average *capacity* is a trifle less than 6 dry quarts (6.6 litres). The *thickness* of the walls hardly varies at all from 3/16 of an inch, and any given piece is of almost exactly the same gauge from bottom to lip. The thinnest sherd I have encountered measures 5/32, the heaviest ¼ of an inch.

SMALL BOWLS (fig. 1, *b*). Our three specimens measure 8½, 8½ and 7 inches in diameter, with depths of 3⅞, 3⅜ and 3¼ inches; *orifice-depth indices* are accordingly .45, .39, .46. The two larger ones have a *capacity* of about 2 dry quarts (2.2 litres), the small one holds 1 dry quart (1.1 litre.) The sides of all three rise a little more steeply than do the walls of the large bowls; rim section and thickness of wall are the same as in large bowls.

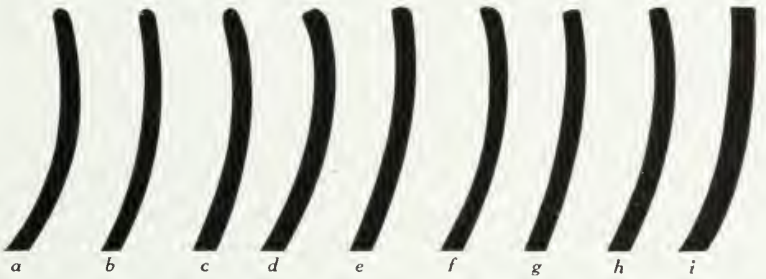


Fig. 2. Glaze I Red. Bowl rim profiles. There is perfect gradation from rounded to flat lips. Note uniformity of curve of vessel walls. (1/2)

OLLAS

The decorated olla, or water jar, which was very seldom made at Pecos in Black-on-white ware, which apparently was entirely absent from Biscuit A, and rather uncommon in Biscuit B, came into its own during the Glaze periods. We have, however, extremely few perfect, or even reasonably complete, specimens, because the Pecos almost never buried such vessels with the dead; and we recovered little restorable pottery, either bowls or ollas, from the ruined houses. Our collection of whole pieces therefore fails to represent the former abundance of ollas, although it is certain, from the refuse sherds, that a great many of them were in use. Their frequency, relative to bowls, was perhaps as high as one to four or five.

Of Glaze I Red ollas (figs. 1, *d*; 6, *c*, *e*, *f*; 72, *a*, *b*) we have more whole examples than of any other type, two having come from graves and one from a ceremonial cache in the plaza. These, with the sherds, permit a reasonably accurate description. The *base* is gently curved, with no flattening. The *body* is low in proportion to its

[1] Formula: $\frac{\text{Depth} \times 100}{\text{Orif.}}$

Fig. 3. Glaze I Red. Bowls. *a-c:* Band patterns. *d:* Pendent triangle pattern. (Diam. of *b*, 13 inches)

Fig. 4. Glaze I Red and Local Glaze I Red. Bowls. *a*, *b:* Glaze I Red; *a*, Lune pattern; *b*, Pendent rectangle pattern. *c*, *d:* Local Glaze I Red. (Diam. of *b*, 12¾ inches)

width; it is, as a rule, somewhat fuller and rounder below the shoulder than above. The *shoulder* itself is round rather than angular. The *neck* approaches, but seldom quite attains, the vertical (fig. 5); the *rim* is direct, i.e., unthickened, with no constriction or flare; the *lip* is usually rounded, sometimes flat.

Our three ollas measure as follows: No. 72774 (fig. 6, *f*), height 10 inches, diameter at shoulder 14, diameter of orifice 6¾, capacity 13½ dry quarts (14.4 litres); No. 66487 (fig. 6, *e*), height 10¼, diameter 15, orifice 6⅛, capacity 13½ dry quarts (14.4 litres); No. 69707 (fig. 6, *c*), height 9, diameter 13½, orifice 6¼, capacity 11½ dry quarts (12.2 litres). Olla sherds average $^{3}/_{16}$ of an inch in thickness, they are thus of the same weight as those of bowls, but pieces as thin as $^{5}/_{32}$ of an inch are more frequently observed than in the case of bowls.

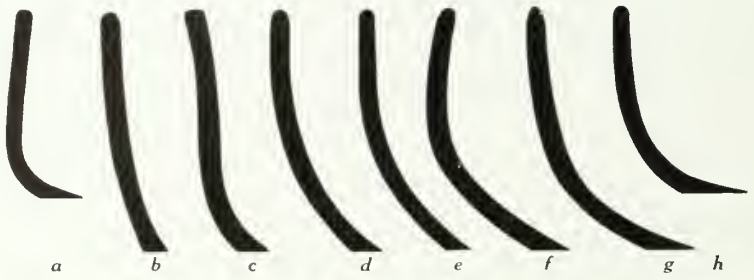


Fig. 5. Glaze I Red. Olla rim profiles. (1/2)

GENERAL DECORATIVE FEATURES

Colors. Black, usually lustrous, glaze on a dark red background. There is but a single sherd of a vessel, corresponding in other respects to the canons of Glaze I Red, which has any part of the decoration in white (fragment of an olla, fig. 24, *n*).

Slip extent. *Bowls:* red slip covers the entire surface, both inside and out. *Ollas:* slipped over the whole exterior, including the bottom, as well as upon the inside of the neck to its base.

Zones of decoration. *Bowls:* save for an occasional pair of dashes or a cross on the exterior just below the rim, are decorated only on the upper part of the interior. The lip is never decorated; in this regard Glaze I Red differs strikingly from Biscuit, whose bowl lips are normally embellished with dots; Black-on-white bowl lips are also often dotted. *Ollas:* decorated on the upper body, the zone beginning at, or more often slightly above, the shoulder and ending at the upcurve of the neck. The neck is never decorated. The pattern is normally a band, framed above and below by a single heavy, unbroken line (figs. 6, *e*, *f*; 72, *a*, *b*).

Fig. 6. Glaze ollas. *a:* Glaze III. *b:* Glaze II-III (?); this specimen, although found at Pecos, is probably not of local manufacture. *c*, *e*, *f:* Glaze I Red. *d:* Glaze I Yellow (Cieneguilla Glaze-on-yellow) olla from Cieneguilla, N. M.—reproduced by courtesy of N. C. Nelson and the American Museum of Natural History (A.M.N.H. cat. no. 29.0-4278). (*Ca.* 1/6; except *d*, whose height is 8½ inches)

BOWL INTERIOR DECORATION

There are, in addition to a very few unclassifiable or "freak" treatments, four methods of bowl decoration, two common, two rare:

Bands (fig. 7, *a*)	27
Pendent triangles (fig. 7, *b*)	13
Pendent rectangles (fig. 7, *c*)	2
Lunes (fig. 7, *d*)	4
Aberrant patterns	2
	48

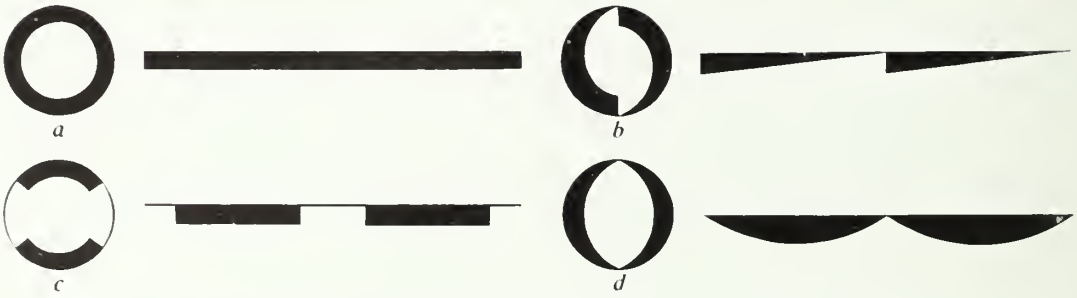


Fig. 7. Glaze I Red. Methods of bowl decoration. *a:* Band. *b:* Pendent triangles. *c:* Pendent rectangles. *d:* Lunes. (Diagram)

The figures appended to the above tabulation are for complete vessels: the sherds, of which several thousand have been examined and from which many of the illustrations of single panels and of decorative elements have been drawn, indicate that the relative frequencies of the four methods are fairly correctly shown by this small series. One of the most striking differences between the decorative syntax of Glaze I Red and that of both the precedent Black-on-white and the contemporaneous Biscuit A, is the large amount of clear space in the bottom of Glaze I Red bowls. In other words, Glaze I Red bands average narrower than those of Black-on-white and very much narrower than those of Biscuit A. The pendent triangle patterns, as well as the rarer pendent rectangles and lunes, also leave much unornamented background. All-over treatments seem never to occur.

BAND PATTERNS

Area covered. *Bowls:* interior from just below the lip downward for from 2 to 4½ inches, leaving the entire bottom, and often part of the lower wall, undecorated. *Ollas:* upper body from at, or just above, shoulder to base of neck. The neck is undecorated.

Framing.[1] Bands are framed in about 60% of all cases; unframed in about

[1] *Framers* are lines closely paralleling a band, but not in contact with it. *Banding lines* form the actual upper and lower margins of a band; the decorative elements are in direct contact with the banding lines. See, for example, fig. 9, *d;* the two outer lines are framing lines, the two within them are banding lines.

40%. Of the framed bands, the majority (nearly 70%) have but a single framer, a heavy line, ¼ to ½ inch wide, encircling the bowl ¼ to ½ inch below the lip, the distance between the framer and the band being usually the same as that between framer and lip (for typical examples see fig. 9, *a*, *f*, *g*). Examination of the complete bowls shows that the framer often, but by no means always, contains a broad "line break" or "exit space."[1] In the 20% or so of bands which are framed both above and below, the framing lines are somewhat narrower (see fig. 9, *c*, *d*). In only one such case (fig. 9, *c*, upper framer) is there an exit space. The band proper is enclosed above and below by a thin, unbroken, banding line.

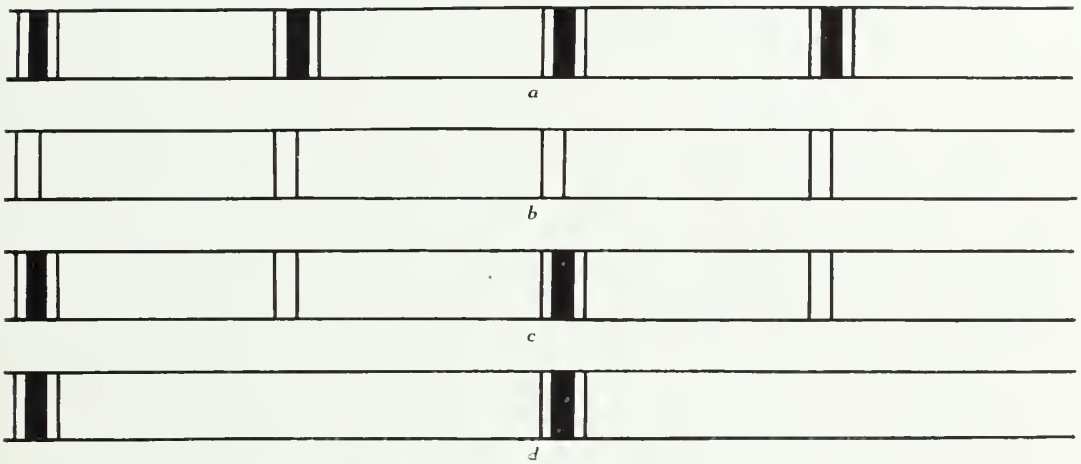


Fig. 8. Glaze I Red. Methods of panel division. *a:* By four heavy bars flanked by narrower paneling lines. *b:* By four open spaces between pairs of narrow paneling lines. *c:* Combination of bar and open space paneling. *d:* The rare two-panel arrangement; the bar, rather than the open space, was apparently always used in such cases. (Diagram)

Paneling. The bands are almost invariably paneled, that is to say, they are cut into rectangular subdivisions (fig. 8). The paneling is accomplished in two different ways: by means of a heavy unengaged bar between two narrow engaged[2] paneling lines (fig. 8, *a*); or by means of two narrow engaged paneling lines with an open space between them (fig. 8, *b*). There are normally four panels, much less commonly two (fig. 8, *d*). In four-panel patterns there is almost always an alternation of two unlike panels, an arrangement which may be expressed by the formula A,B,A,B (see figs. 9-11).

[1] A deliberately produced interruption in a major encircling line is a common feature in the decoration of late prehistoric and modern Pueblo pottery. The distribution, both chronological and geographical, of this peculiar practice should be worked out. Its meaning is discussed by Guthe (1925, p. 86) and Bunzel (1929, p. 69).

[2] By "engaged" is meant that elements of the decoration are attached to the lines in question.

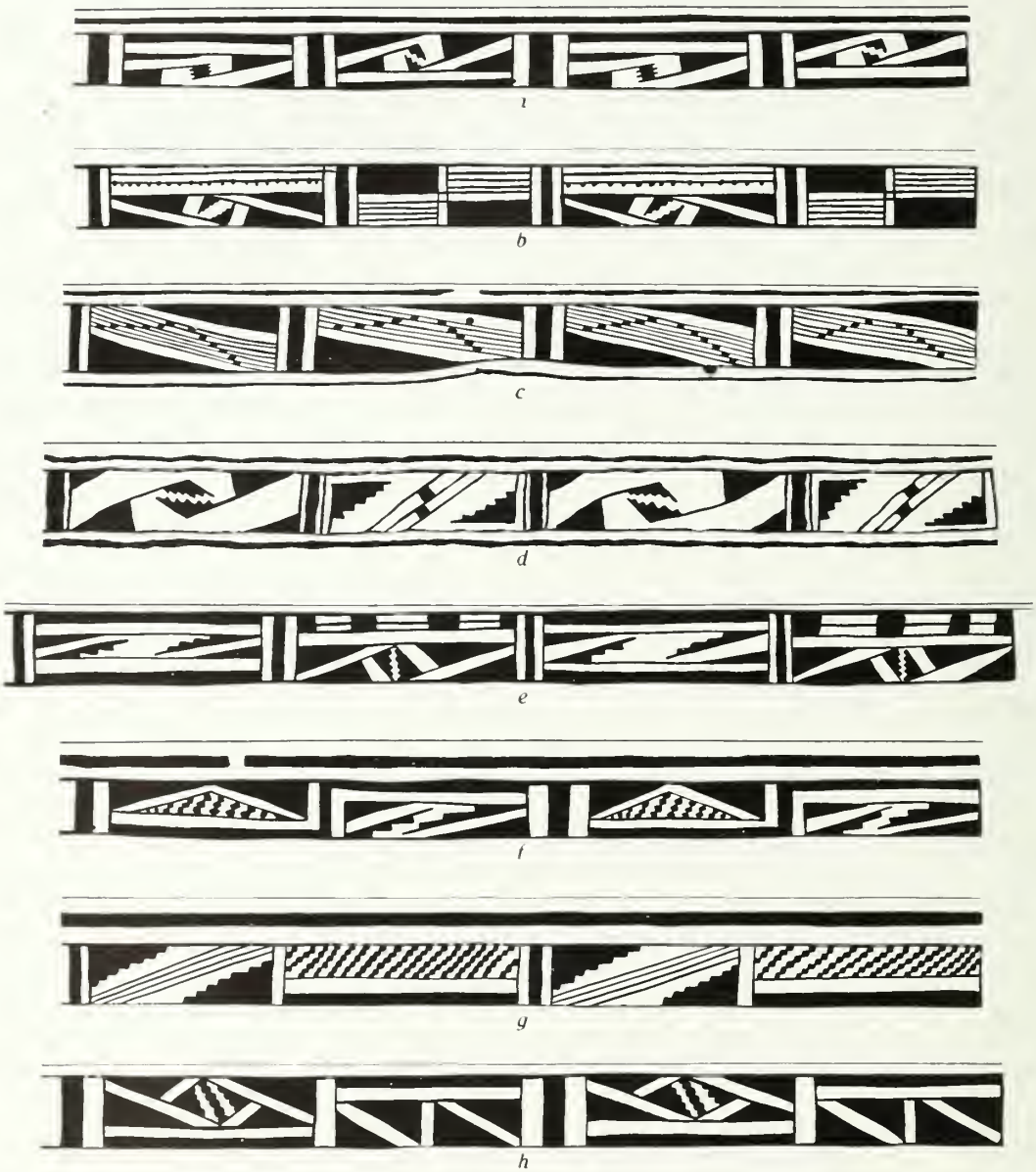


Fig. 9. Glaze I Red. Band patterns from bowl interiors. Paneling by heavy vertical bar. (1/8)

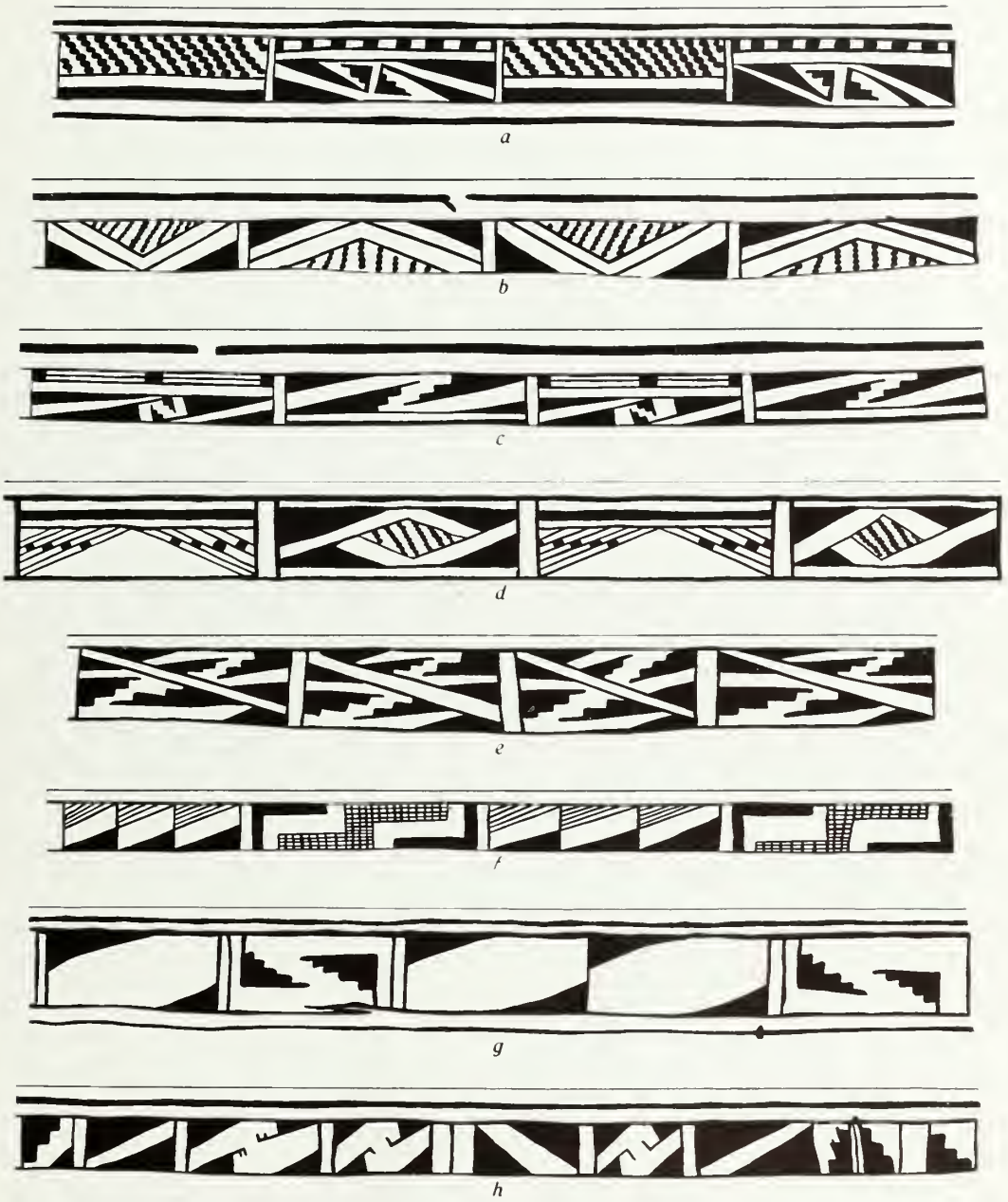


Fig. 10. Glaze I Red. Band patterns from bowl interiors. Paneling by vertical open space. (1/8)

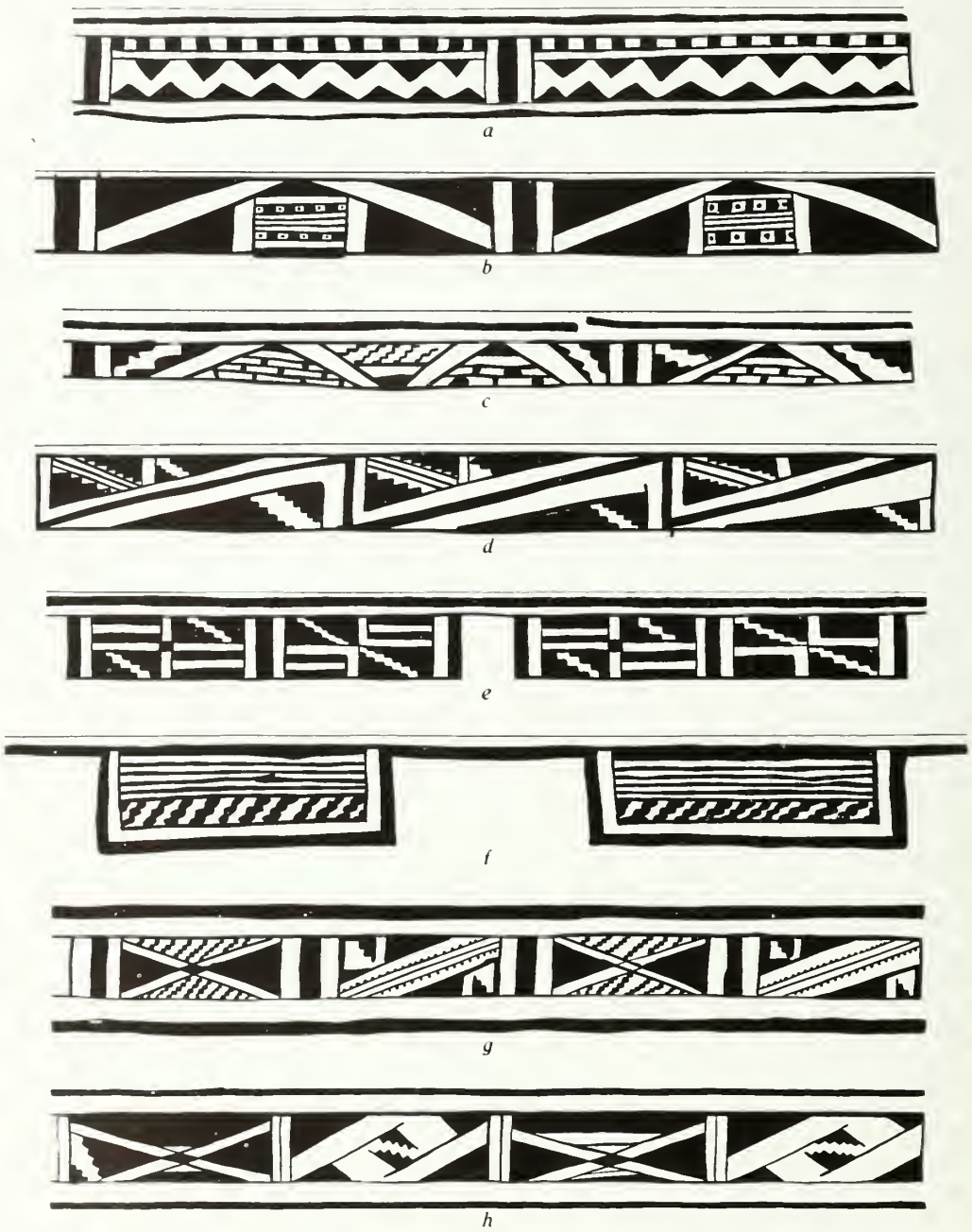


Fig. 11. Glaze I Red. Band and pendent rectangle patterns from bowls and ollas. *a*, *b*, *c:* Two-panel arrangement. *d:* Three-panel (the only example in the collection). *e*, *f:* Pendent rectangle patterns. *g*, *h:* Bands from ollas (cf. fig. 6, *f* and *e* respectively). (1/8)

Panel layout. Because the band is cut into but four subdivisions, the latter are of course long and narrow, their length being on the average nearly three times their width. The problem of ornamenting these somewhat attenuated fields was solved in a number of ways. In a little more than half of all cases the panel was filled without further reduction in size; in the rest it was made still narrower by the introduction of one or more lines set a little away from, and parallel with, either the upper or the lower banding line (e.g., fig. 9, *b*, left-hand panel). The field (unreduced panel or narrowed panel) was subdivided in the following manners (asterisks indicate absence from the Glaze I Yellow collection):

Horizontal line (fig. 12, *a*)
*Simple cross (fig. 12, *b*)
Double cross (fig. 12, *c*)
Oblique line (fig. 12, *d*)
*Simple X (fig. 12, *e*)
*Double X (fig. 12, *f*)
Corner lines (fig. 12, *g*)
Stalks for opposed elements or slung rectangle (fig. 12, *h*)
Triangle (fig. 12, *i*)

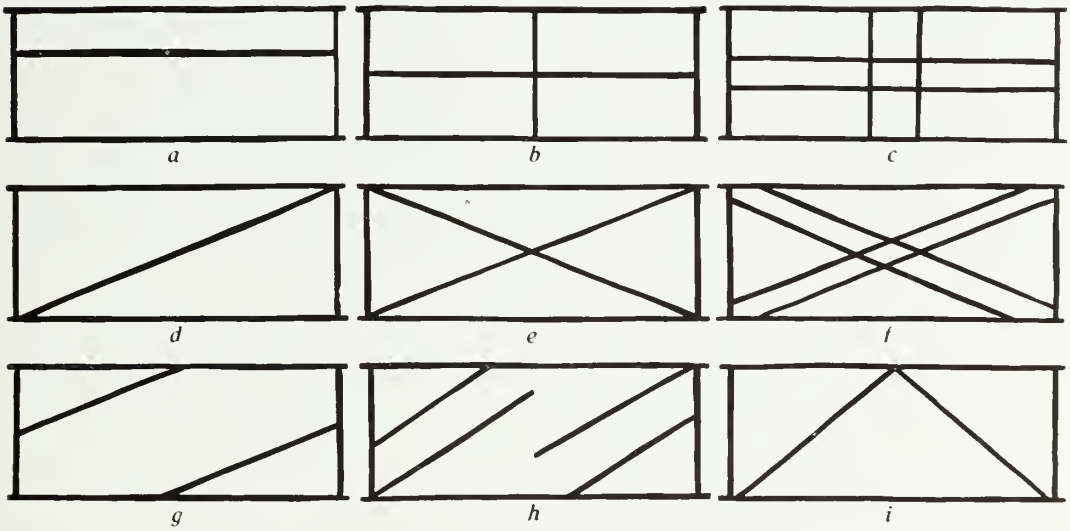


Fig. 12. Glaze I Red. Methods of panel subdivision. *a:* Horizontal line. *b:* Simple cross. *c:* Double cross. *d:* Oblique line. *e:* Simple X. *f:* Double X. *g:* Corner lines. *h:* Stalks for opposed elements. *i:* Triangle. (Diagram)

Horizontal line (fig. 12, *a*). A very common treatment. The line which produces the division is usually either close to the top or the bottom of the panel. It thus forms two unequal sub-fields, one wider than the other. Elaboration may consist merely of dotting along the line itself (fig. 13, *a*, *b*); of the introduction of extra lines with dotting (*c*, *d*); or of heavy extra lines without dotting (*e*, *f*). The narrower sub-field is at times embellished with checkerboard, plain (*k*) or dotted (*l*). Other methods of treatment are: filling the wider sub-field with oblique stepped lines (*g*, *h*, *i*); with small triangles opposed (*k*) or in a single row (*l*); or even of cutting it into two sub-sub-fields which were handled as small panels (*m*, *n*). In many instances the broader sub-field becomes an attenuated panel which is in turn subdivided in one or another of the methods to be described below (see, for example, fig. 16, *b-d*).

Simple cross subdivision (fig. 12, *b*) seems to have been rare. It only appears on one of the complete bowls (fig. 11, *e*, second and fourth panels; the panel is reproduced in fig. 14, *e*); there are, however, several sherds showing parts of what apparently were panels of this sort. The dividing lines serve, of course, to break the field into four smaller rectangles, each one of which is decorated.

Double cross (fig. 12, *c*). This more elaborate method is commoner than the foregoing (see fig. 14, *a*, *b*, *c*, *d*, *f*). The double horizontal and vertical lines originate from the middle of the sides of the panel, cutting the field into four rectangles and a small central square. The rectangles are treated as minor panels. In their elaboration the principle of alternation, so regularly observed in all Glaze I Red decoration, has been followed, upper left being balanced against upper right, lower left (which repeats upper right) against lower right. The elements used are heavy lines (fig. 14, *c*); crosshatching (*a*); hatching (*b*); solid fill (*a*, *b*); zig-zagged lines (*f*); and opposed keys, stalked (*d*) or unstalked (*c*). The small central square is usually, but not always (*b*) filled solid. In view of the fondness of the Glaze I artists for placing a dot in such a space, it seems odd that they apparently never did so when these squares were left open.

Oblique line (fig. 12, *d*). This is one of the commonest methods of laying out the panel. A line or, more frequently, a series of lines crosses the panel sinistrally (i.e., from upper left to lower right) or dextrally from opposite corners, dividing it into two triangular fields. If a single line is used it may be plain (as in fig. 15, *a*); or dotted (*b*). The series or sets of lines may also be either plain (*h*) or dotted (*e*). At times the oblique dividing element takes on the same forms employed in the narrow fields of horizontal layouts, i.e., dotted checkerboard (*d*) or an arrangement of three parallel lines with large, blobby dots at centre and ends (*c*). The triangular fields are variously handled; most often their corners are merely cut off parallel to the central oblique dividing line and filled solidly with glaze (*a-d*, *f*); in other instances they contain key figures (*e*, *g-j*); these will be discussed below with the other manifestations of this very abundant element. Lastly, among oblique arrangements, must be included certain more severely geometric figures such as those shown at *k*, *m*, *n*. These are formed by a combination of oblique and vertical lines producing series of triangles and parallelograms.

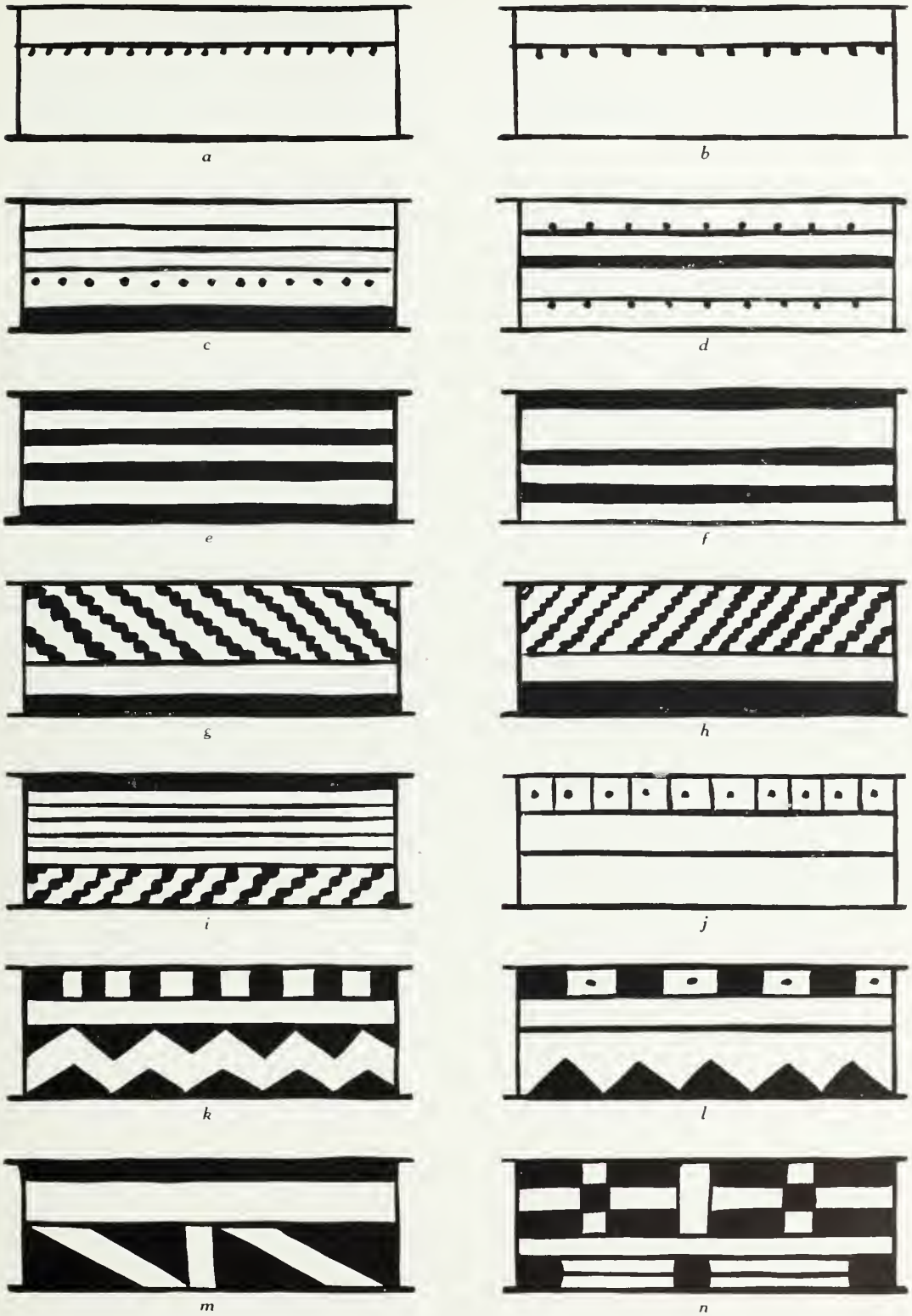


Fig. 13. Glaze I Red. Panels subdivided by horizontal lines. The panels here reproduced and in similar figures throughout this book have been brought to uniform size and in some cases lines have been straightened; they are otherwise faithful copies.

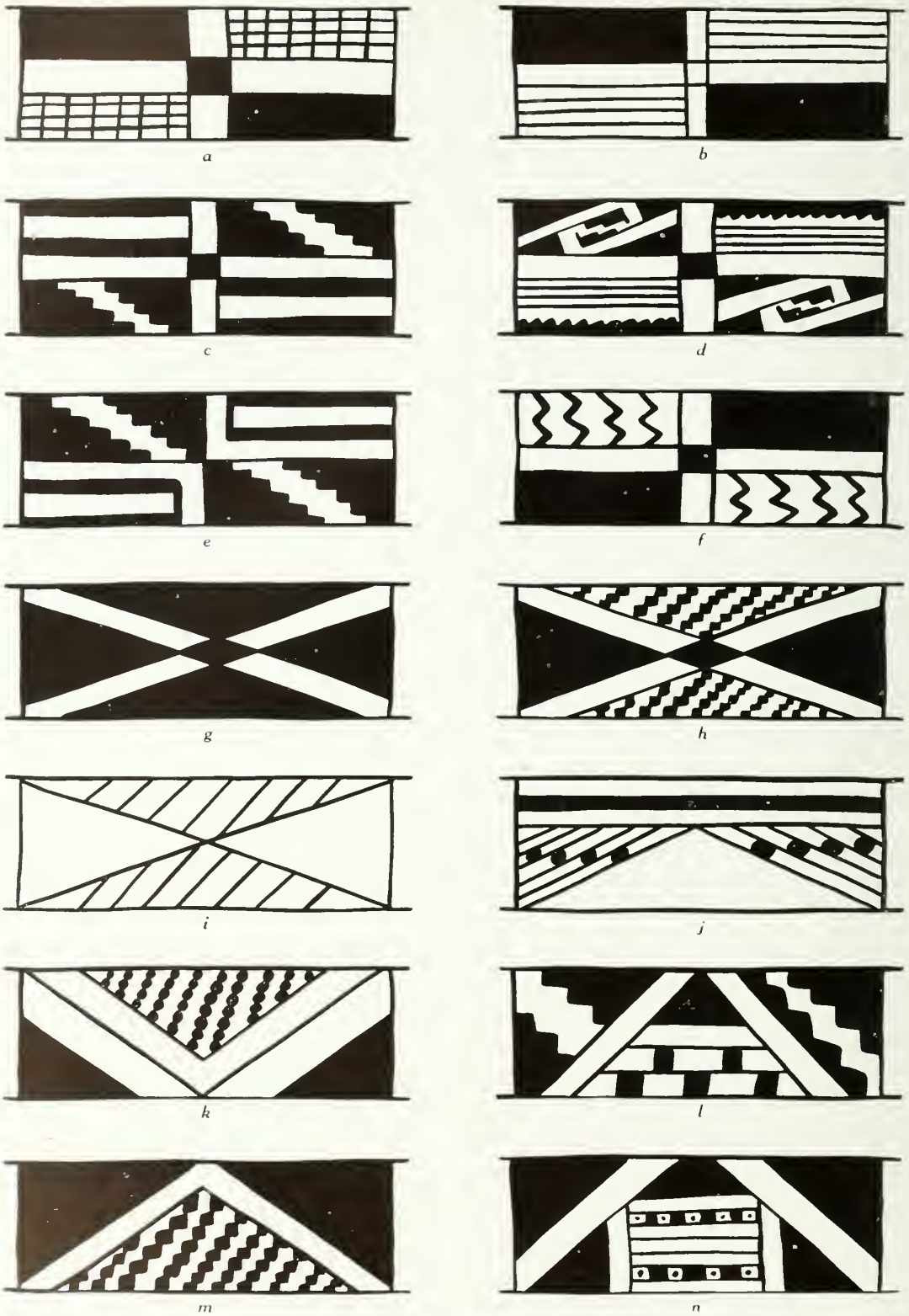


Fig. 14. Glaze I Red. Panel subdivision. *a-d, f:* Double cross. *e:* Simple cross. *g, h:* Double X. *i:* Simple X. *j-n:* Triangle.

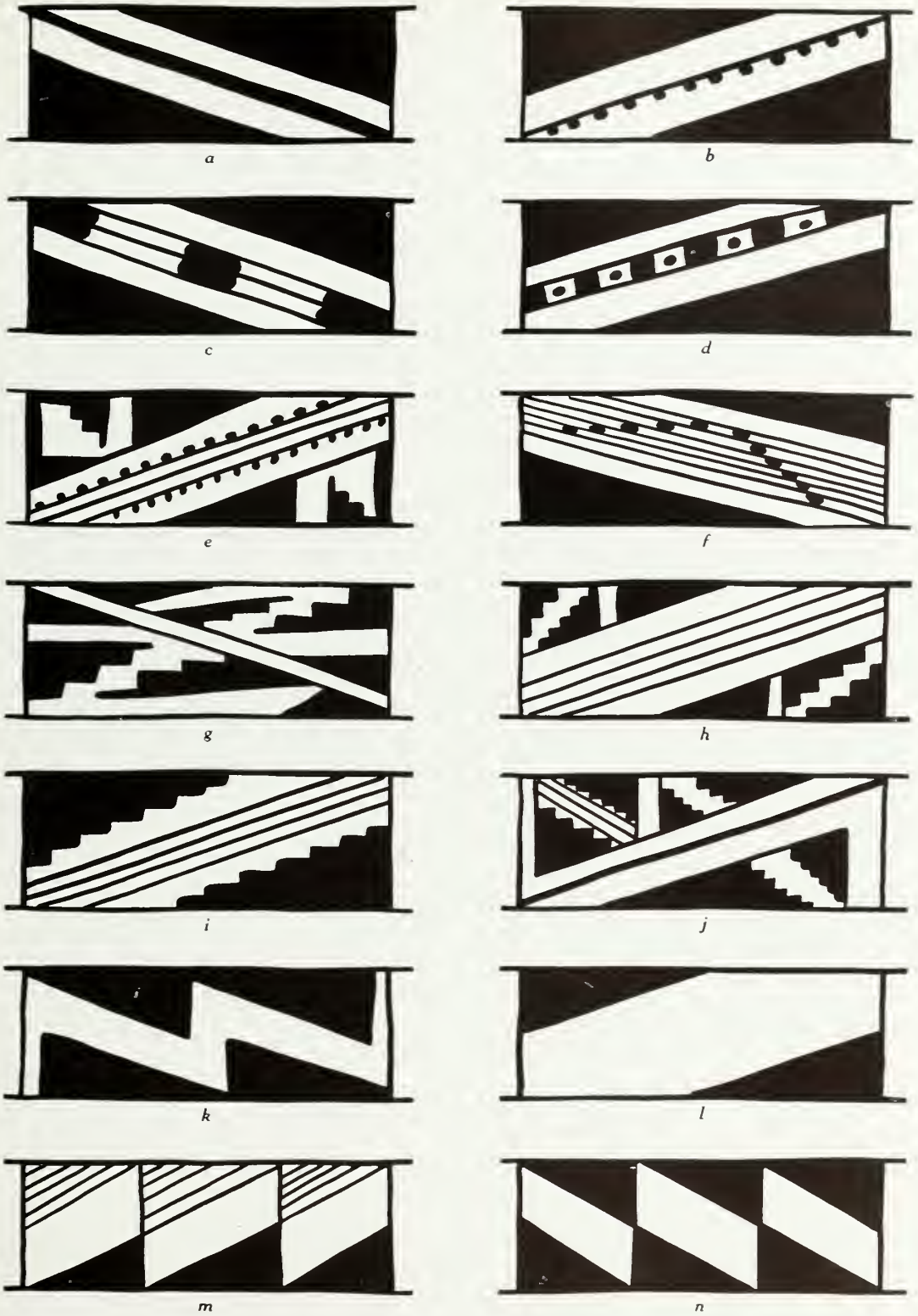


Fig. 15. Glaze I Red. Panel subdivision. *a-j:* Oblique line or lines. *l:* Corner lines. Other oblique arrangements are shown in *k*, *m*, *n*.

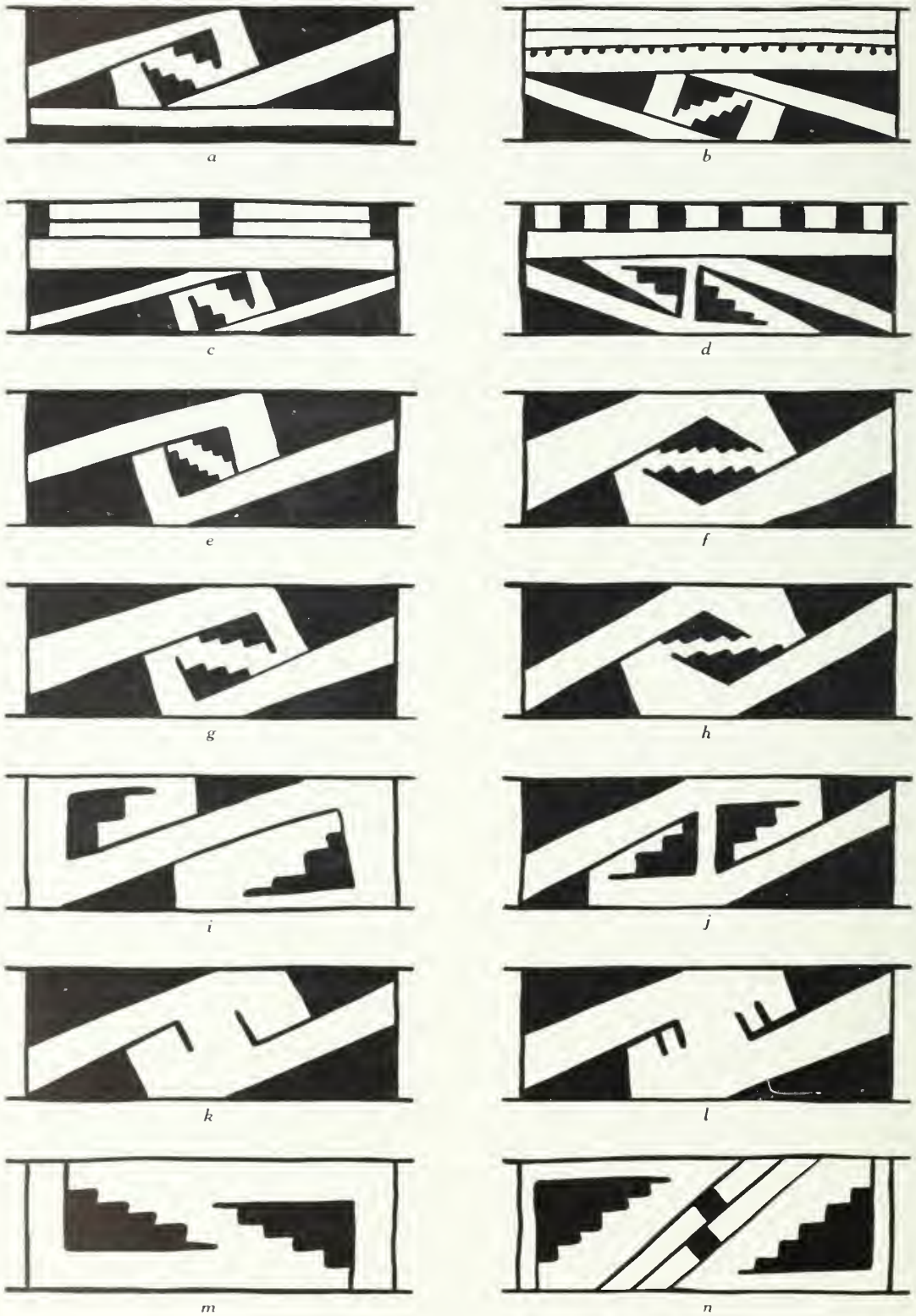


Fig. 16. Glaze I Red. Panels containing stalked key figures and (*k*, *l*) birdlets.

Simple X (fig. 12, *e*), like simple cross, is rare. Two lines, originating from opposite pairs of corners transect each other at the middle of the panel, creating four triangular fields, the upper and lower of which, in the only complete example, are hatched (fig. 14, *i*). There are one or two sherds which show what seem to be parts of similar arrangements.

Double X (fig. 12, *f*). In the collection of whole vessels there are not many panels so subdivided; but among the sherds, particularly those of ollas, the pattern is fairly well represented. As in the double cross, the resulting small central field (in this case diamond-shaped) is usually black. The four triangular fields may all be black (fig. 14, *g*) or more elaborately ornamented with hatching, stepped lines (*h*), etc.

Corner lines (fig. 12, *g*). This very unsophisticated layout occurs but seldom; usually, on the evidence of the sherds, in bands upon small bowls. Two opposite corners of the rectangular panel are cut off obliquely by parallel lines and the triangular spaces so enclosed are filled solidly (fig. 15, *l*). The resultant design, though rare in Glaze I Red, is abundant in Glaze II and III. The cutting off of corners, as a method of laying out panels is, it may be remembered, conventional in the Standard Band panels of Biscuit A and B;[1] in the Biscuit designs, however, the triangular fields were again subdivided.

Stalks for opposed elements or slung rectangle (fig. 12, *h*). The panel layout now to be considered ranks with the horizontal line arrangement as most typical of Glaze I Red. The two, indeed, are often combined (see fig. 16, *a-d*), preliminary subdivision being by the horizontal line, with the wider of the two resultant fields occupied by opposed elements. The cutting of the panel is oblique, but instead of a single line crossing from corner to corner, single shorter lines issue from diagonally opposite corners, but at such an angle that they pass each other (see fig. 12, *h*). These two lines serve as the stalks of key-figures, whose heads are placed in direct (fig. 16, *a*, *b*, *c*) or inverted (*d*, *j*) opposition; the two lines also serve as backbones, so to speak, for elongated, unstalked keys (fig. 17, *i-n*); and as bases for certain little square or diamond-shaped elements which I call slung rectangles (fig. 17, *a-h*). These will be discussed below. All three of the arrangements just mentioned (stalked and unstalked keys and slung rectangles) leave triangular spaces in the two remaining corners of the panel and at the bases of the stalks; these, with characteristic Pueblo *horror vacui*, were cut off and painted solidly with glaze.

Triangle (fig. 12, *i*). This simple system of panel subdivision is represented more abundantly in the designs on the whole vessels than seems justified by the evidence of the sherds. It consists of the drawing of lines from two adjacent lower or upper corners of the rectangle to the middle of the opposite side, thus dividing it into one large and two small triangular fields. The smaller triangular fields were usually blacked (fig. 14, *k*, *m*, *n*), the larger one was filled with stepped lines (*k*, *m*), or otherwise enriched.

[1] Vol. I, figs. 36, p. 88; 58, p. 108.

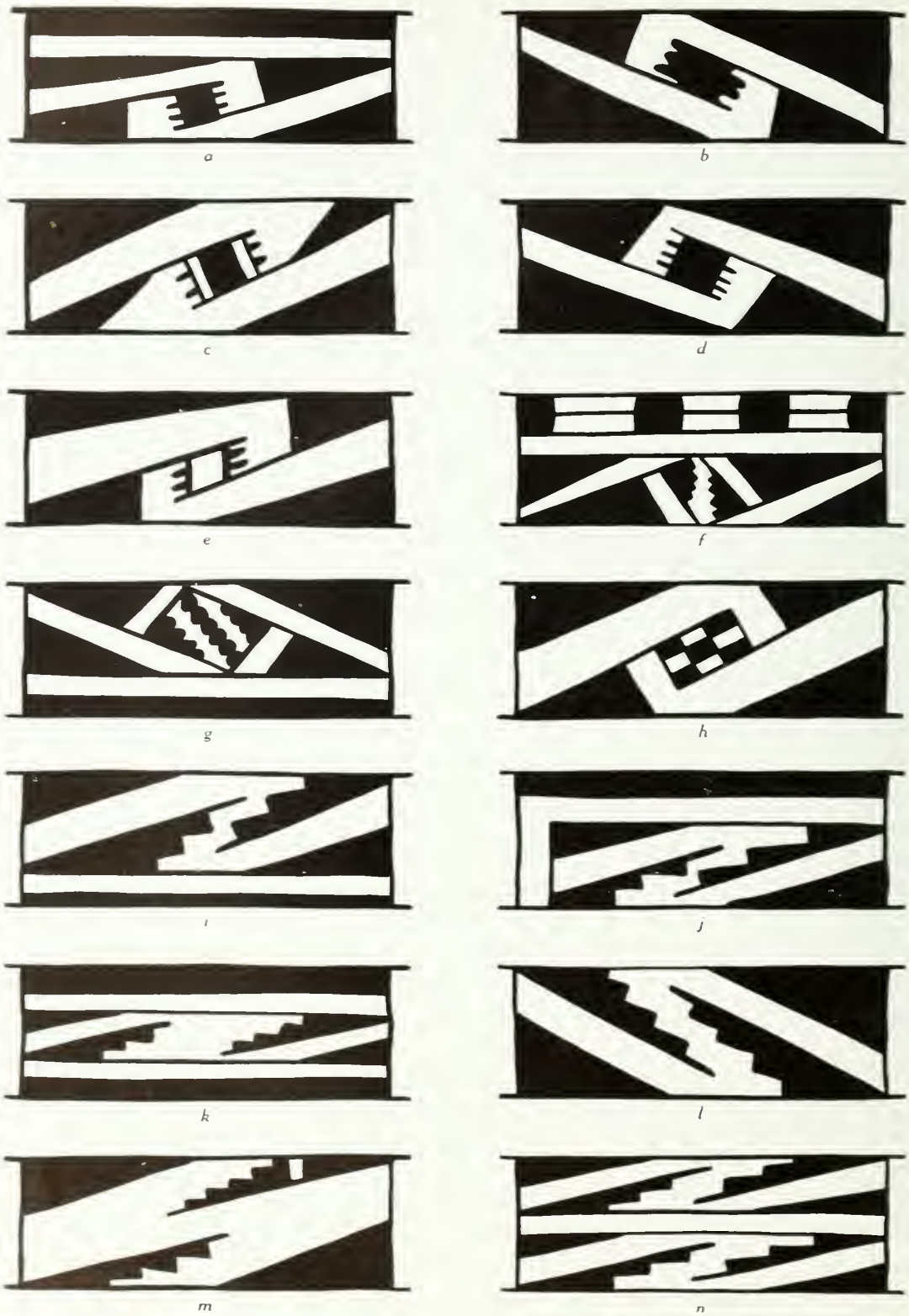


Fig. 17. Glaze I Red. Panels with slung rectangle (*a-h*) and elongated, unstalked key figures (*i-n*).

UNPANELED BANDS

A very few bands were not paneled. We have but one complete specimen, a small bowl (fig. 18, *a*). There are, however, three or four sherds (out of the many hundreds examined) which show that, in addition to the X-arrangement illustrated by the little bowl, there were certain bands of recurring pairs of opposed key figures (fig. 18, *b*, *c*, *d*).

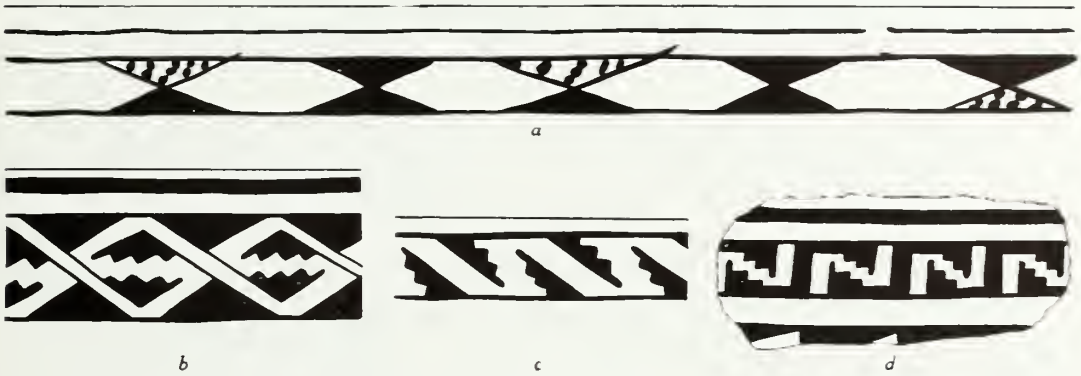


Fig. 18. Glaze I Red. Unpaneled band patterns, all from bowl interiors except *d*, which is a ribbon-like band lying above the main decorative field of an olla. (1/8)

PENDENT TRIANGLE PATTERNS

AREA COVERED. Upper part of bowl interior (figs. 3, *d*; 7, *b*). Does not occur on ollas.

FRAMING. A single heavy line, like that of many band patterns, often encircles the bowl just below the lip and a somewhat greater distance above the triangles (fig. 19, *a*, *c*, *e*); it is unbroken by an exit space. The triangles depend, in all cases but one (fig. 20, *c*), from a narrow, unbroken line encircling the bowl below the framer (if it be present) or (if it be absent) close below the lip. This line corresponds to the upper banding line of the band patterns.

STRUCTURE. There are normally two triangles. Their short, perpendicular sides lie opposite each other (see fig. 7, *b*). The hypothenuse of each triangle slants gradually upward to the right to meet the banding line at (fig. 19, *d*) or close to (*a*) the perpendicular side of the other triangle. There is but one example, a three-triangle pattern (*f*) in which the hypothenuse rises to the left. A two-triangle arrangement, as has been said, is characteristic; in the collection, however, are two of three (figs. 19, *f*; 20, *c*) and two of four (figs. 19, *e*; 20, *d*).

ELABORATION. The field to be oranmented is long and narrow. It is thus analogous to the band, except for its gradual taper to the ultimate meeting of its two longer sides. The influence of band technique is evident, each of the two triangles generally being divided, as well as its shape permits, into two panels. The resultant panels are accordingly four in number, as in a band; and they exhibit the A,B, A,B, alternation of two unlike panels, which is typical of bands.

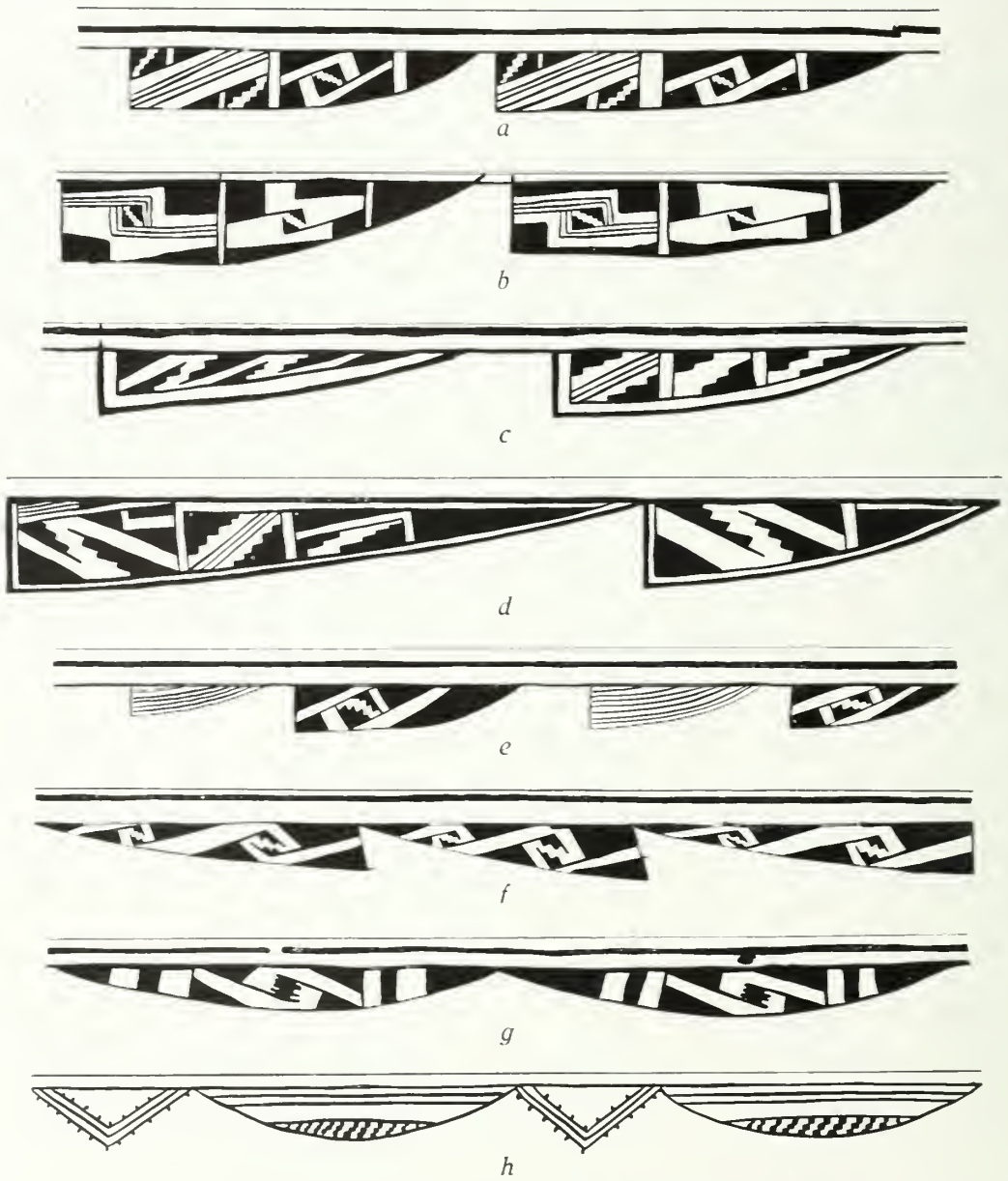


Fig. 19. Glaze I Red. Pendent triangle patterns (*a-f*) and lunes (*g*, *h*). The curve of the triangle's long lower side in this and the following figure is caused by the flat projection; on the concave surface of the vessel this line is straight, while in the case of the lunes it is actually bent counter to its direction as copied. (1/8)

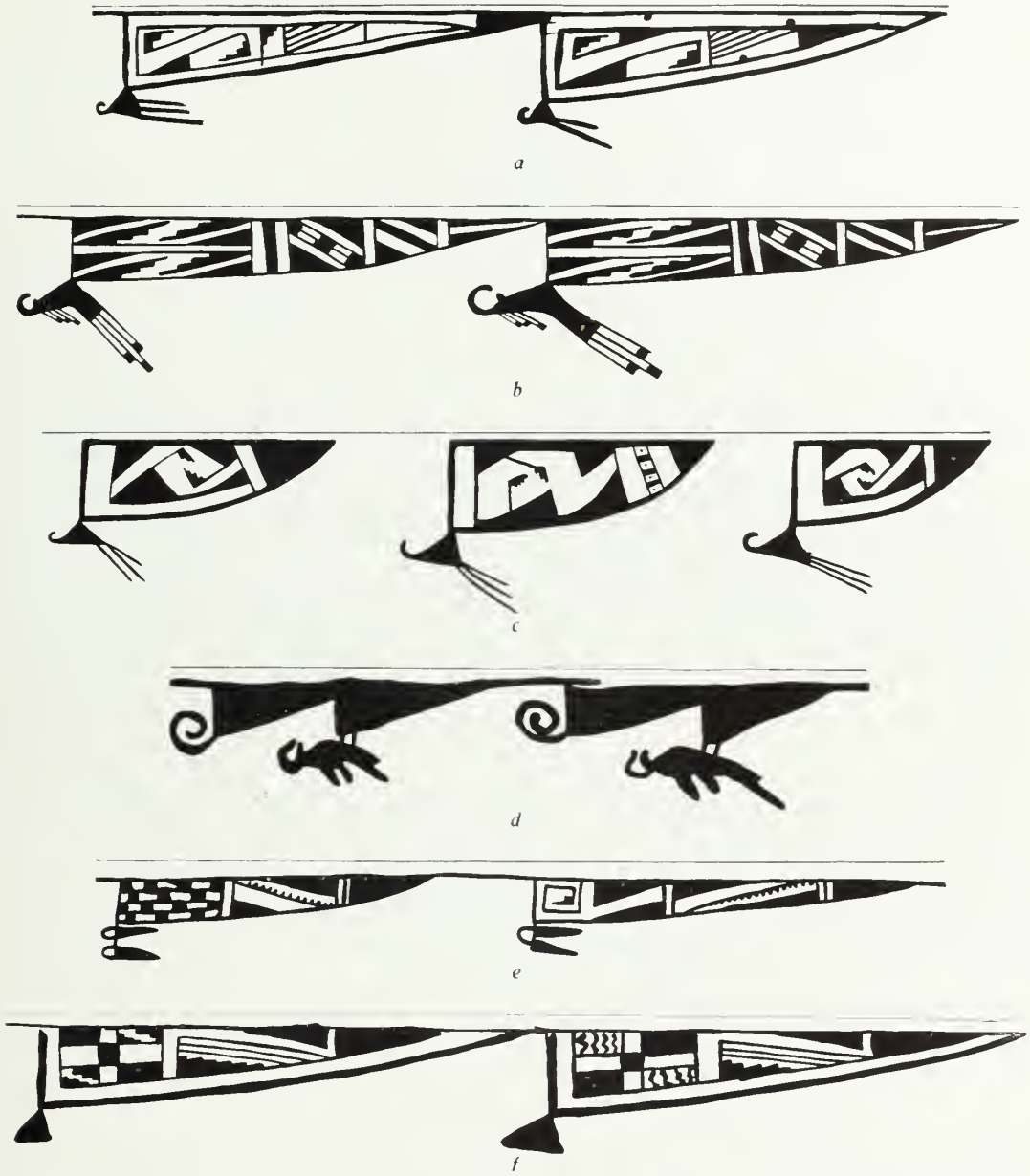


Fig. 20. Glaze I Red. Pendent triangle patterns with bird and other figures. The scroll terminations of *d* are unusual; the vessel from which the pattern was copied is otherwise atypical and should perhaps have been classified as Glaze II. (1/8)

Panel division, again as in bands, may occasionally be by bars (fig. 20, *b*), although the more usual method is by narrow, vertical open spaces (figs. 19, 20); subdivision and the elements of internal embellishment are identical with those of band panels, always allowing, as was said above, for the gradual narrowing of the field. The tapering end of the triangle was usually filled solidly with glaze, in accordance with the extreme dislike of Pecos potters for leaving vacant any angular space.

In about half the complete specimens in the collection—and the sherds indicate that this is approximately the usual ratio—the downward-pointing apexes of the triangles bear an added device, usually a bird (fig. 20).

PENDENT RECTANGLE PATTERNS

AREA COVERED. Upper part of bowl interior. These patterns are, in essence, merely interrupted bands (figs. 4, *b*; 7, *c*).

FRAMING. As in bands: with or without a single heavy upper framer, the two rectangles hanging from what corresponds to the upper banding line of a band.

ELABORATION. In one of our two whole specimens (fig. 11, *e*) the long rectangular fields are paneled and the panels are filled in exactly the same manner as in bands, the A,B,A,B alternation being followed, although in this particular case the two B panels are not identical. In our other specimen (fig. 11, *f*) there are two repeating panels (A,A) the open spaces between them possibly having satisfied the potter's desire for contrasting alternation.

LUNE PATTERNS[1]

AREA COVERED. Two elongated fields on opposite sides of the upper part of the bowl interior, leaving free of decoration a large pointed oval space (figs. 4, *a*; 7, *d*). The term "lune" is correctly applicable to most manifestations of this pattern, for the two fields, as painted on the concave surface of the bowl, are as a rule actually semi-lunar. Occasionally, however, the lines cutting the sub-fields from the larger field of the bowl's interior surface are straight (in the sense of the "great circle" curve); in such cases the sub-fields are elongated, pointed ovals. When straightened out and transferred to a flat surface (as in the diagram, fig. 7, *d* and in fig. 19, *g*, *h*) all varieties of this design become of necessity festoon-like.

FRAMING. Sometimes with, sometimes without, a heavy, broken, single framer above (fig. 19, *g*, *h*). The lunes themselves are attached to a narrow line set just below it.

ELABORATION. The broad middle part of the lune field is occupied by a panel; the tapering ends are black (fig. 19, *g*; see also fig. 50, in which are illustrated examples from the much larger Glaze I Yellow series). The unusual pattern in fig. 19, *h* consists of lunes alternating with triangles.

[1] Lune, a crescent-shaped area bounded by two intersecting arcs of circles on a plane surface or a sphere—Webster.

ABERRANT PATTERNS

Although the canons of Glaze I Red decoration were fairly rigidly followed, the sherds indicate that a certain amount of latitude was permitted, particularly in the detailed treatment of the elements used for the elaboration of panels. Examples of such treatments appear in fig. 24. Rarely, however, did patterns diverge as widely from standard as do those of the bowls illustrated in fig. 21. Realistic depictions, even so crude as the quadruped and the human head in fig. 21, *a*, are very unusual (a sherd bearing a closely similar head is reproduced at *b*). Curvilinear patterns are even more seldom seen, only one bowl being so treated (fig. 21, *c*); the sherds provide no further evidence of major curvilinear planning; they also indicate that the scroll was practically never used (the only example appears in fig. 24, *k*).

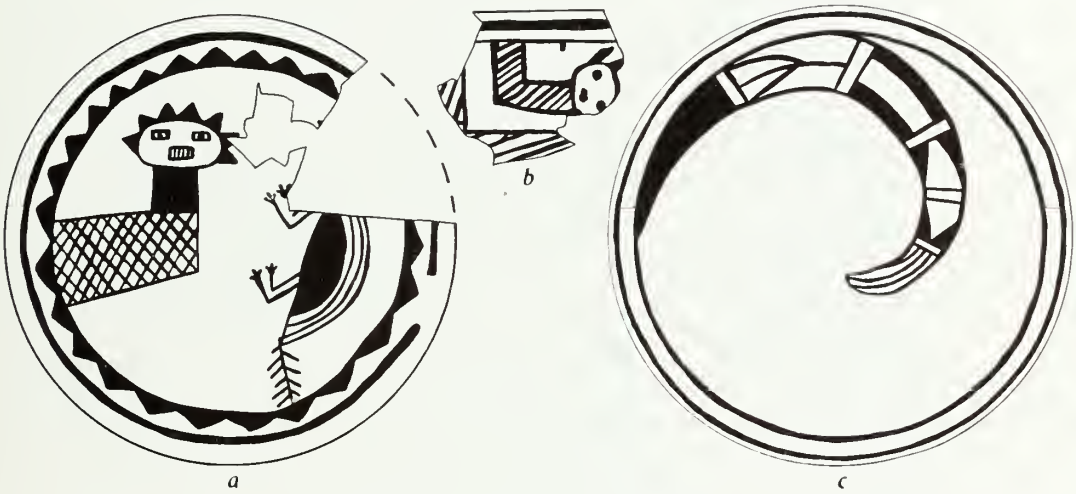


Fig. 21. Glaze I Red. Aberrant bowls. *a:* Fragmentary specimen from a disturbed grave; the animal appears to be unique, the human head is almost duplicated in the sherd, *b* (note bent "neck," lack of nose, rayed headdress). *c:* Curvilinear arrangement; even this very unusual pattern is treated, as well as its shape allows, in the manner of the paneled band. (*Ca.* 1/6)

ELEMENTS OF GLAZE I RED DECORATION

Lines. Aside from their very important services in framing and subdividing patterns, and in outlining areas subsequently to be filled with solid pigment, lines were sparingly used. Multiple framers, hatching, cross-hatching, sets of lines bordering major or minor fields; none of these was in favor. But the Glaze I Red line is nevertheless notable, in comparison to the lines of other Pecos decorative systems, for its firmness and accuracy. Whether broad or narrow it is drawn with a steady hand; it preserves, as a rule, a remarkably even width; it is straight and clean-edged (see fig. 22).

Fig. 22. Glaze 1 Red. Typical sherds. *a-e*, *i* from bowls, the rest from ollas. (Width of *k*, 5½ inches)

As was remarked in discussion of the glaze, the paint was seldom so compounded as to maintain a steadily uniform consistency. Hence individual brush strokes may often be discerned. This permits reasonably accurate reconstruction of the methods of the painter, a matter which seems worth considering at this point in some detail, because it illustrates so clearly the role of the line, and also because the steps taken in the creation of designs throw light upon the way in which the potter approached her decorative problems.

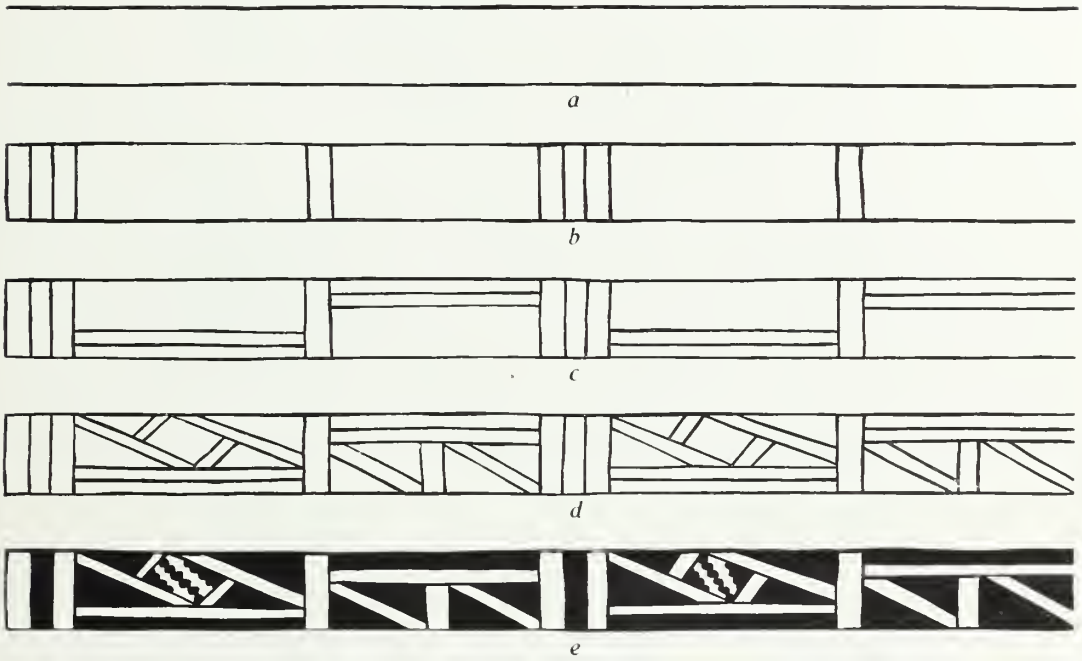


Fig. 23. Glaze I Red. Growth of a band pattern. *a:* Banding lines drawn. *b:* Paneling accomplished. *c:* Panels reduced. *d:* Framework of ultimate elements drawn. *e:* Fillings applied to complete the pattern. The major steps in the above process are in correct sequence; it is, however, impossible to tell whether each panel was subdivided, and its elements outlined and filled, before the next one was elaborated; or whether these processes were carried out in the above order for all the panels together. (Diagram)

First came the heavy upper framer, when present, followed by the narrower banding lines. It is to be supposed that the framer, placed highest and therefore most easily located by reference to the fixed line of the rim, was the initial step.[1] It was usually drawn with a brush sufficiently broad to give the desired width with a single stroke. A few unusually broad framers can be seen to have been made by painting two parallel, thinner lines and filling between them; more commonly, when one stroke was not enough, the framer consisted of two heavy lines, one slightly overlapping the other laterally. An occasional pattern is executed with so sure a

[1] As is the practice at the Pueblo of San Ildefonso today; see Guthe, 1925, p. 67.

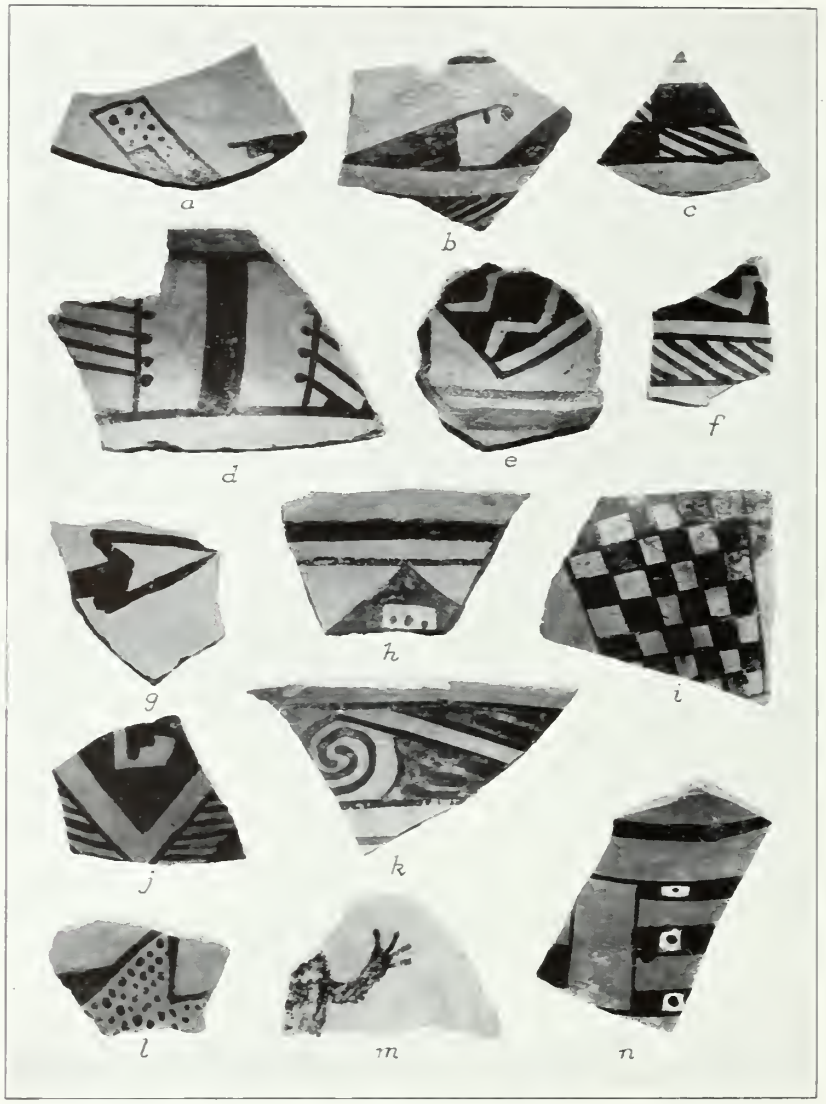


Fig. 24. Glaze I Red. Sherds with unusual decorations. *a:* Dots used for filling. *b:* Birdlet. *c:* Black and hatching in contact (probably bad workmanship). *d:* Dots on vertical paneling lines. *e:* Opposed triangles in series, the diamond-shaped interspaces occupied by linked black diamonds. *f:* Hatching, ribbon type. *g:* Arrowhead (?). *h:* Three dots in reserved rectangle. *i:* Checkerboard as fill for a large area. *j:* Simple key introverted in triangular field (a common device in certain other regions). *k:* Interlocking scrolls. *l:* Dot-filled area. *m:* Naturalistic figure. *n:* Dotted checkerboard ribbon with white fillings. *b*, *c*, *i*, *j*, *n* from ollas, the rest from bowls. (Width of *k*, 4¾ inches)

touch, and in so excellent a paint, that one cannot make out the longitudinal junctions of the brush marks; and its framer gives the impression of having been painted, as perhaps it actually was, with a single continuous motion, possibly by slowly revolving the pot. But as a rule it was done with trailing strokes 3 to 6 inches long (one can often identify individual strokes by irregularities in the line itself and also, at times, by a thickening of the glaze deposited by the freshly-dipped brush at the point of its first contact).

Following the heavy upper framer, or as a first step if that feature was omitted, were drawn the two narrow banding lines (fig. 23, *a*). These almost always give evidence of repeated slightly overlapping strokes, although the work was often done so carefully that there remains no trace of their junction beyond the above-mentioned thickening of the pigment. They are, in the run of well-painted specimens, about $^{3}/_{32}$ of an inch wide; seldom are they as thin as $^{1}/_{16}$, somewhat more often $^{1}/_{8}$ of an inch. Strokes of this range of width were standard in Glaze I Red decoration, all subsequent outlining and all free-standing line-work being carried out with them. Whether they were made by some manipulation of the large brush used for framers and for filling, or whether, as seems more probable, the painter possessed implements of two sizes is uncertain.[1]

The banding lines once run in, the long space between them was subdivided by the vertical paneling lines (fig. 23, *b*). The four-panel arrangement normal to Glaze I Red made the spacing of these an easy matter. They were so carefully drawn that they seldom trail across the banding lines either above or below (but see fig. 11, *b*, left of left-hand panel). If paneling was by bars, four lines were drawn, two for the engaged paneling lines and two to outline the bar which was later filled (fig. 23, *b*). The bar was never, as far as I can make out, produced by a single broad stroke, presumably because it would be very difficult cleanly and without overlap to join so heavy and "blobby" an application of paint to the thin banding line. If the bar was omitted, two narrow lines served to produce a vertical open space to separate the panels (see fig. 8, *b*).

The preliminary layout was now accomplished, and there had been achieved the equal, balanced sub-areas so dear to the heart of all Pueblo decorators.[2] The final elaboration of the sub-areas or panels was sometimes taken in hand at once, but very often the passion for reduction of the field expressed itself by narrowing the panels still further with one or more horizontal lines (fig. 23, *c*). This process has been considered in the analysis of the panels (p. 15), here it suffices to say that overlaps on many specimens prove it to have been done before the framework of the ultimate elements was drawn. If the elements were to be large, solid figures, their outlines were run in first, this being done with long, thin, single strokes (fig. 23, *d*). They were then filled by multiple, heavy daubs (*e*). Dots, "blob steps," "squiggled" lines and the steps of small key-figures were produced without prior outlining; the steps of larger key-figures were first outlined, then filled.

[1] The San Ildefonso potters use three widths of brushes, all made from yucca leaf; Guthe, 1925, p. 67.

[2] Guthe (1925, pp. 66-69 and 78-84) gives much valuable information as to the planning and execution of designs; see also Bunzel, 1929.

So much for the structural role of the line. As an independent device it was not greatly used. In certain horizontally subdivided panels, however, lines constitute the sole decoration; narrow lines, in such cases, are usually dotted (fig. 13, *a-d*); heavy lines are plain (fig. 13, *e*, *f*). A single line or a set of three to five parallel lines sometimes crosses a panel obliquely, but it is then either subordinated, in interest, to the elements in the panel's corners (fig. 15, *a*, *h*, *i*, *j*); or serves as medium for elaboration by marginal dotting (*b*, *e*) or by dots in oblique stepped series between multiple lines (*f*). A peculiar treatment, which occasionally appears in obliquely designed panels (fig. 15, *c*) as well as in the narrower field of horizontally planned panels (figs. 13, *n*; 17, *f*), consists of three parallel lines with heavy, blobby dots across their ends and at intervals between.

Hatching is distinctly uncommon. It seems practically to be confined to the filling of triangular fields (figs. 14, *i*; 15, *m*). The lines of the hachure are of the same weight as those which confine them, i.e., of the approximately $^{3}/_{32}$-inch gauge usual in Glaze I Red.

Cross-hatching is rarer still, occurring only in certain ribbon-like fields (the neck of the anthropomorphic representation in fig. 21, *a*, for example), where it is of the oblique or diamond variety; and in small rectangular areas (fig. 14, *a*) where it is right-angled.

Stepped lines. These, as may be observed in the illustrations, are extremely common. They constitute, indeed, one of the diagnostic characters of Glaze I, both Red and Yellow. Their direction is either dextral or sinistral. Very short lines were sometimes, though even then not always, produced by a continuous stroke, without raising the brush from the vessel's surface. These I call "*squiggled*" stepped lines. Much more commonly, however, they were made by repeated applications of the brush, short dabs sufficiently offset to give a stepped effect. These are termed "*blob-step*" lines (fig. 22, *i*, *k*). The above distinctions may seem absurdly fine, but sooner or later comparisons will have to be made between lines of this sort from various regions and from different chronological horizons, and details of brushwork may well prove to have genetic as well as classificational significance.

Dots are often used in series for edging the horizontal or oblique dividing lines of panels (figs. 13, *a-d*; 15, *b*, *e*); and, singly, in the open squares of ribbon checkerboarding (figs. 13, *l*; 14, *n*). They also appear in the dotted "eye" (see p. 33). Dots are occasionally arranged in oblique, offset series between closely set parallel lines in such a way as to form a simple design, the effect of which is not unlike that of the stepped line (figs. 14, *j*; 15, *f*). As a filling device dots are rare (examples may be seen in fig. 24, *a*, *h*).

Ticks. These are marks formed by a short stroke of the brush rather than by the touch of the brush-tip that makes the dot. Dots set along lines or on the edges of solid areas produce a beaded, ticks a fringed, effect. It is naturally sometimes difficult to distinguish ticks from dots, and their separation may seem an unnecessary refinement. But, as was remarked in discussing the stepped line, we shall ultimately be required to take into account all such details of technique; and in some decorative systems (that of early Developmental Pueblo, for example) the tick is a

very useful diagnostic trait. In Glaze I Red it is rare, the only occurrence apparently being upon the slung rectangle (fig. 17, *a-e*).

Checkerboard is all of the square variety, that is to say, the two sets of lines which constitute its framework are at right angles to each other. We have no case of diamond checkerboarding. Considerable areas were seldom filled with checkerboard, the largest one in the collection is seen on the sherd reproduced in fig. 24, *i*. Smaller fields containing three or four rows (fig. 17, *h*) are not unusual, but the commonest way of using this device is in a single row, the unfilled squares being left open (fig. 13, *k*) or, more frequently, dotted (*l*).

Dotted "eyes". Although we have no examples in the decorations of our whole vessels, there are several sherds which show that it was a not unusual practice to leave open or "reserve" in a large black-filled triangular field, or in a heavy key figure, a small square or circle, the middle of which was embellished with a single dot (fig. 22, *c*, *l*).

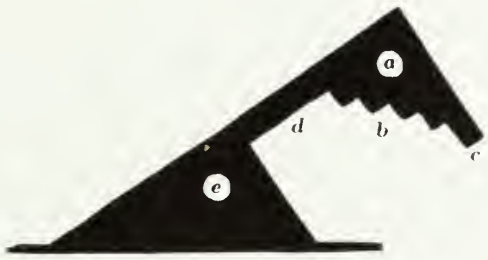


Fig. 25. Key figure, stalked type with base. *a:* Key. *b:* Face. *c:* Terminal step. *d:* Stalk. *e:* Base. (Diagram)

Key figures. The key is a three-sided figure, two of whose sides are straight, the third terraced, dentate, scalloped, dotted, or otherwise ornamentally modified. The key may be stalked (see diagram, fig. 25 for nomenclature of its parts) or unstalked.[1] In Glaze I Red the key appears in four distinct forms (fig. 26); stalked with base (*a*), stalked without base (*b*), unstalked right-angled (*c*), unstalked oblique (*d*). It is, in this type, invariably used in balanced, usually directly opposed, pairs.

Stalked key with base. This is one of the most typical of all panel-fillers. The illustrations, particularly fig. 16, *a-j*, present its essential features more clearly than any amount of description. There should, however, be noted: the oblique set of the paired figures; their delicate stalks; the close opposition of the faces, which have from three to five or six steps; and the thin, delicate terminal step. The other steps were "blobbed" in without previous outlining and are, in consequence, slightly rounded rather than angular. The bases are triangular, filling the two corners from which the figures emanate; the other two corners of the panel are blacked in

[1] The figure in question is indubitably the most important element in all Southwestern ceramic decoration; a thorough comparative study of its manifold chronological and regional manifestations would throw much light upon the origin and the interrelation of Southwestern pottery groups.

to complete the pattern. The heads, if their faces are not in direct opposition, are occasionally placed back to back (fig. 16, *j*). When two of these keys fill triangular fields in an obliquely halved panel (rather than meeting, as they usually do, in the panel's centre), their stalks are bent twice and each head backs up against its respective base (fig. 15, *e*). This arrangement occurs but once in the Glaze I Red collection; attention is called to it, however, because it is common in Little Colorado decoration.

In the rare instances in which bands are not paneled, the stalked key with base forms an admirable running design (fig. 18, *b*).

Stalked keys without base (fig. 26, *b*), though much less common, were, on the evidence of the sherds, a regular part of the decorator's stock-in-trade. They are large-headed and are supported on thin, vertical stalks. Paired in panels, they rise from the upper and lower banding lines respectively, their five- or six-stepped faces not in close opposition (fig. 16, *m*, *n*).

Fig. 26. Glaze I Red. Varieties of the key figure. *a:* With stalk and base. *b:* With stalk and no base. *c:* Unstalked right-angled. *d:* Unstalked oblique. (Diagram)

Unstalked right-angled keys (fig. 26, c). This form of key is used only to fill small rectangular fields, parts, as a rule, of panels with double cross subdivision (fig. 14, *c*, *e*). They are backed into diagonally opposite corners of these restricted areas; their four- to six-stepped faces lie so close together as to produce the effect of a diagonal white stepped line crossing a black field. An adaptation of this type of key to a triangular space is seen in fig. 14, *l*.

Unstalked oblique keys (figs. 17, *i-n;* 26, *d*). These figures are very typical of Glaze I Red, almost equalling in abundance the stalked keys with base. They, too, rise in pairs from diagonally opposite corners of panels; their terminal step is likewise attenuated to a mere line. Their faces, however, seldom interlock and often in narrow fields (fig. 17, *k*) they do not even overlap. Their long, straight backs and their two or three saw-tooth, rather than square, steps are characteristic. A single example in an unpaneled band design was noted among the sherds (fig. 18, *c*).

Slung rectangle. One is forced to use a drawing to explain this coined term.[1] The device is illustrated, for the benefit of the harassed reader, in fig. 27, *b*. Little comment is necessary. The general arrangement is very similar to that of the paired stalked keys with base: two stalks with bases like those of the stalked keys emerge from diagonally opposite corners of the panel, pass each other, and are

[1] I am far from proud of this, and various other names used for patterns and elements. Appelatives of some sort must, however, be devised if one is to avoid the constant repetition of cumbersome descriptions.

joined by a small rectangle, usually, but not always, solidly blacked, and generally fringed with ticks (fig. 17, *a-e*). Inner embellishment sometimes replaces the exterior fringing: opposed keys (*f*); stepped line (*g*); checkerboard (*h*). Genetic relationship to the paired stalked keys is to be suspected.

Birdlet.[1] This is closely akin to the stalked key with base. It differs from it, however, in that the stepped key head is replaced by a single short line (fig. 16, *k*) or a pair of short lines (fig. 16, *l*) at right angles to the end of the stalk. The device is rare in Glaze I Red. The figures appear in opposed, but not interlocking, pairs in panels (fig. 16, *k*, *l*). A single sherd (fig. 24, *b*) seems to indicate its repetition along a line. This is the most common method of using the birdlet in later Glazes.

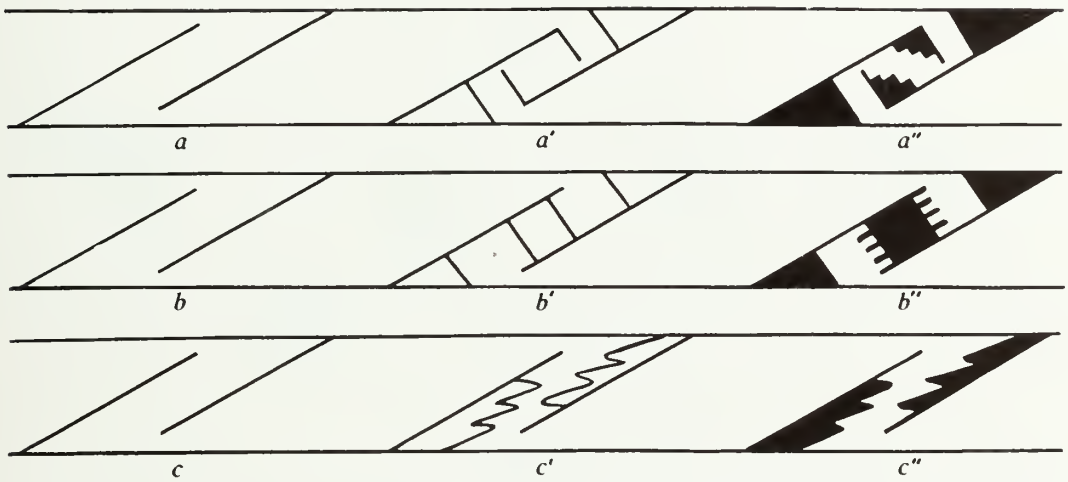


Fig. 27. Glaze I Red. Drawing to show the structural similarity between the oblique stalked key (*a*), the slung rectangle (*b*), and the oblique unstalked key (*c*). Stage c' in the painting of the oblique unstalked key was often omitted, in such cases the serrations were produced without previous outlining. (Diagram)

Birds normally appear in identical pairs, one figure perched on the apex of each of the two triangles of the pendent triangle pattern (fig. 20). The essential features of the bird are body, head and tail (fig. 28); legs are usually omitted (but see fig. 20, *d* and the very similar bird in fig. 30, *a*). The body is simply a black triangle; one of its angles meets the supporting pattern, to the second is attached the head, the tail originates from the third. The head is a short crook; in some cases (fig. 29, *a*) it is obviously a mere continuation of the line of the back; in others (fig. 29, *b*) it is raised above the level of the back and study of brush marks indicates that it was usually added after the body had been drawn. The adding of the line

[1] This term is born of desperation. Some convenient tag had to be given to this very common and widespread element. It bears some resemblance to certain bird figures, it is usually small, hence (but with no artistic or biological implications) the name.

Fig. 28. Glaze I Red. Typical Glaze I bird. Note triangular body, crook head, tail of straight lines; the lack of legs and the position on the apex of a triangle are characteristic. From a sherd. (1/1)

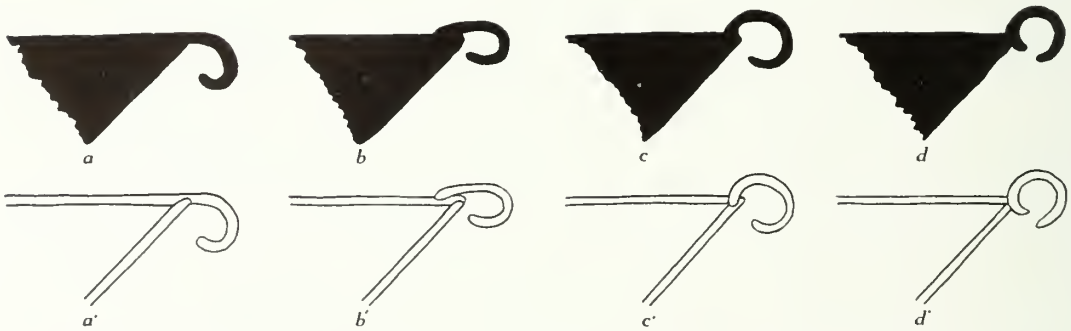


Fig. 29. Glaze I Red. Methods of drawing bird heads. *a:* Continuation of line of back. *b*, *c*, *d:* Added crook; in *d* the inner end of the crook projects to give the appearance of the lower mandible. In the lower row the original lines are reproduced in outline to show succession of brush strokes. From sherds. (*Ca.* 2/3)

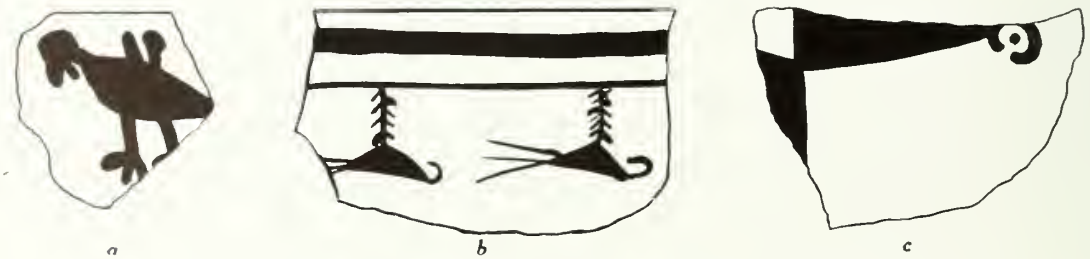


Fig. 30. Glaze I Red. Birds, unusual varieties. *a:* Naturalistic bird with wings and feet, from bowl exterior. *b:* Birds upon plants (?). *c:* Bird with eye (the only case noted in Glaze I Red). (*Ca.* 1/3)

often results in the appearance of a short projection opposite the principal curl of the head (fig. 29, *d*, also seen in the birds of fig. 20, *b*). This projection seems purposely to have been emphasized in drawing the heads of certain of the birds under discussion (fig. 20, *d*); it is even more pronounced a characteristic of Glaze I Yellow birds (fig. 57). It renders the heads more realistic and, indeed, occasionally gives a fairly graphic, if impressionistic, rendering of the short lower mandible of the parrot. Speculation is perhaps justifiable as to whether we cannot see, in this repeating and strengthening of a doubtless originally accidental feature, an instance of naturalization or, perhaps better, realization (as opposed to conventionalization) in design.

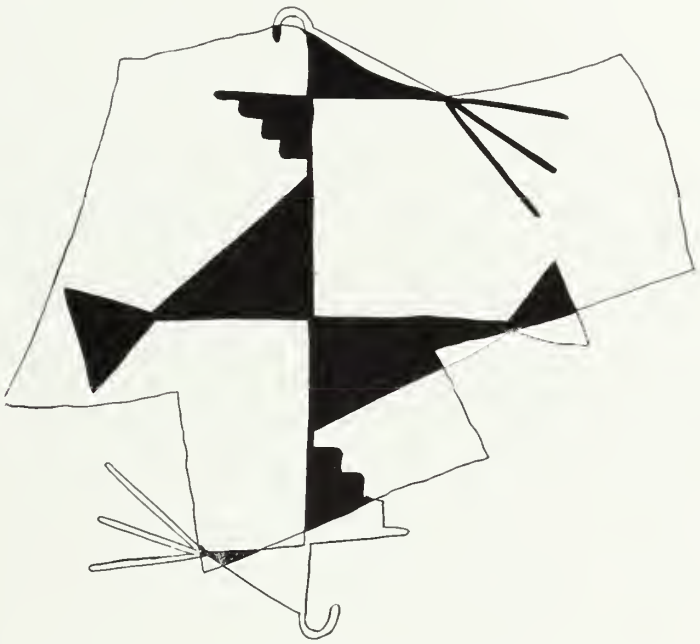


Fig. 31. Glaze I Red. Birds on large, free-standing geometric figure in the bottom of a bowl. Of the second bird, the junction of the tail with the body can be seen in the lower corner of the sherd. (1/2)

The tail of the bird is more variable than the head. Most commonly (on the evidence of the sherds) it consists of two straight brush marks in the same line as the back, or cocked slightly upward; a more elaborate treatment is seen in fig. 20, *b*.

Birds, other than at the apexes of pendent triangles, are rare: a handsome geometric figure with two birds conventionally perched occurs on a sherd from the bottom of a bowl (fig. 31); the two birds on what appear to be trees (fig. 30, *b*) are not only unique as regards position, but present the only possible case of vegetal

representation in any category of Pecos glaze.[1] Birds with legs and wings appear twice, one in the badly painted bowl shown in fig. 20, *d;* once on the exterior of a bowl-sherd (fig. 30, *a*). The eye is represented but once (fig. 30, *c*).

NATURALISTIC REPRESENTATIONS are practically non-existent. Aside from the human heads and the animal illustrated in fig. 21, there is a single sherd from the bottom of a bowl which bears a leg with four-toed foot (fig. 24, *m*).

[1] Jeancon mentions, but does not figure, "birds perched on trees" from a Biscuit vessel from the Chama (1923, p. 48).

GLAZE I YELLOW[1]

This type, it will be remembered, appeared at Pecos a little later than did Glaze I Red. The two were in use together for a considerable time. Yellow, however, gradually gained in relative abundance, Red declining both in amount and in quality, finally becoming, before its total extinction, the wretched stuff which I have segregated for description on pp. 72 to 78 as Local Glaze I Red. Yellow also degenerated, but less rapidly. Nor did it, like Red, pass out of use. It took on certain new features (thickened rim, red exterior decoration) which, with a general falling off of technological excellence, have served as criteria for the recognition of Glaze II.

GENERAL CHARACTERISTICS[2]

Like Glaze I Red, this is two-color pottery, but the dark glaze of its decoration is applied to light-colored instead of red backgrounds.[3]

The term yellow is not to be taken too literally, for while the slips are indeed yellower in general tone than those of any other Pecos type, few examples are actually of that hue. There is wide range in color, from a warm light yellow to almost white. Whether this great variability is due to lack of standardization in firing practice, or to differences in nature of the slip, is uncertain. In this connection it should be remarked that the differences are between vessel and vessel, the surface of any given piece being, save for fire-clouds, of substantially the same color throughout.

On many specimens the slip is a relatively heavy coat; in such cases it is often seamed with fine, wavy crackles; the thicker slips also tend to flake off, exposing the reddish paste. The slip of other pieces is so thin as to be, properly speaking, a wash; the dauby marks of the swab with which it was applied are then plainly visible (fig. 34, *c*, *d*). In certain areas it is so light a coat as to permit the red of the paste to show through, producing a pinkish, clouded effect. The surface is generally smooth, but is never glossy. When heavy slip was used, it appears to have been gone over with a smoothing stone, whose marks are particularly obvious on the exterior of bowls. The thin, "washy" slip was not rubbed after application.

Bowls were evidently always fired upside-down, for dark gray to black fire-clouds with lighter edges are found on the exterior of practically every piece (fig. 35, *a'*, *c'*, *d'*), while they are never seen within. Further proof of the inverted position is provided by the uniformly dark gray interior of certain bowls whose exteriors are light-colored. This is due, without doubt, to the partial exclusion of oxygen from the interior during the burning.

The glaze paint is thin, lies flat on the surface, and holds closely to the lines of its original application. Running is extremely rare (one of the very few instances appears in fig. 50, *g*). Irregular edges are usually due to faulty brushwork. The glaze

[1] Comparable to Mera's "Cieneguilla Glaze-on-yellow."

[2] Miss Shepard's technological description of Glaze I Yellow will be found on pp. 501-502.

[3] The rare polychrome specimens are described on p. 69.

is, on the average, distinctly more lustrous than that of Glaze I Red. It also differs from it in that it never draws together into beads. It often fails to "take," particularly where brushed out thin; but the finest examples are beautifully glossy. In color it has a definitely brownish cast; it is light brown when thin, blacker when heavily applied, but never really black. In many instances there is a bluish iridescence; almost never any suggestion of green.

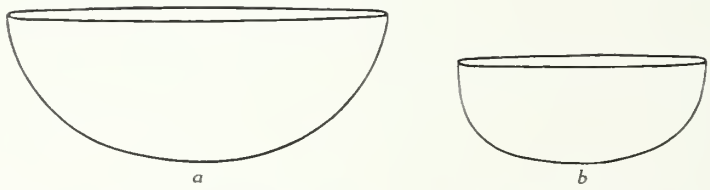


Fig. 32. Glaze I Yellow. Bowl shapes; pieces of intermediate size are not found. For probable olla shape see fig. 1, *d*. (1/6)

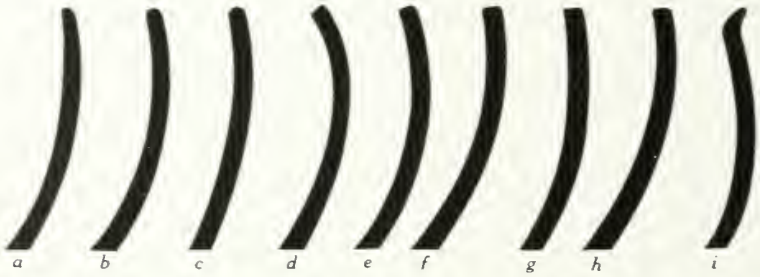


Fig. 33. Glaze I Yellow. Bowl rim profiles. The rounded (*a-c*) are less common than the squared lips (*d-h*). The outcurved form (*i*) is extremely rare. (1/2)

VESSEL SHAPES

BOWLS

As in Glaze I Red, there are many large bowls, relatively very few small ones.

LARGE BOWLS (figs. 32, *a*; 34, 35). Although certain Glaze I Yellow bowls are excellently moulded, most specimens are less true in silhouette and less perfectly circular than the run of Glaze I Red bowls. In general shape, however, the two are identical (cf. figs. 1, 32); and the likeness extends to *rim form* (cf. figs. 2, 33), with a slight tendency toward greater squareness of lip in Glaze I Yellow. The collection contains one complete bowl and six sherds with slightly outcurved rim (fig. 33, *i*); the rarity of this form becomes evident when one takes into consideration the fact that the six sherds were the only ones of the sort found during examination in the field of many thousand fragments. *Size:* the range in diameter is from 10½ to 13½; the average is 11¾ inches. The range in depth is from 4¼ to 6 inches; the average

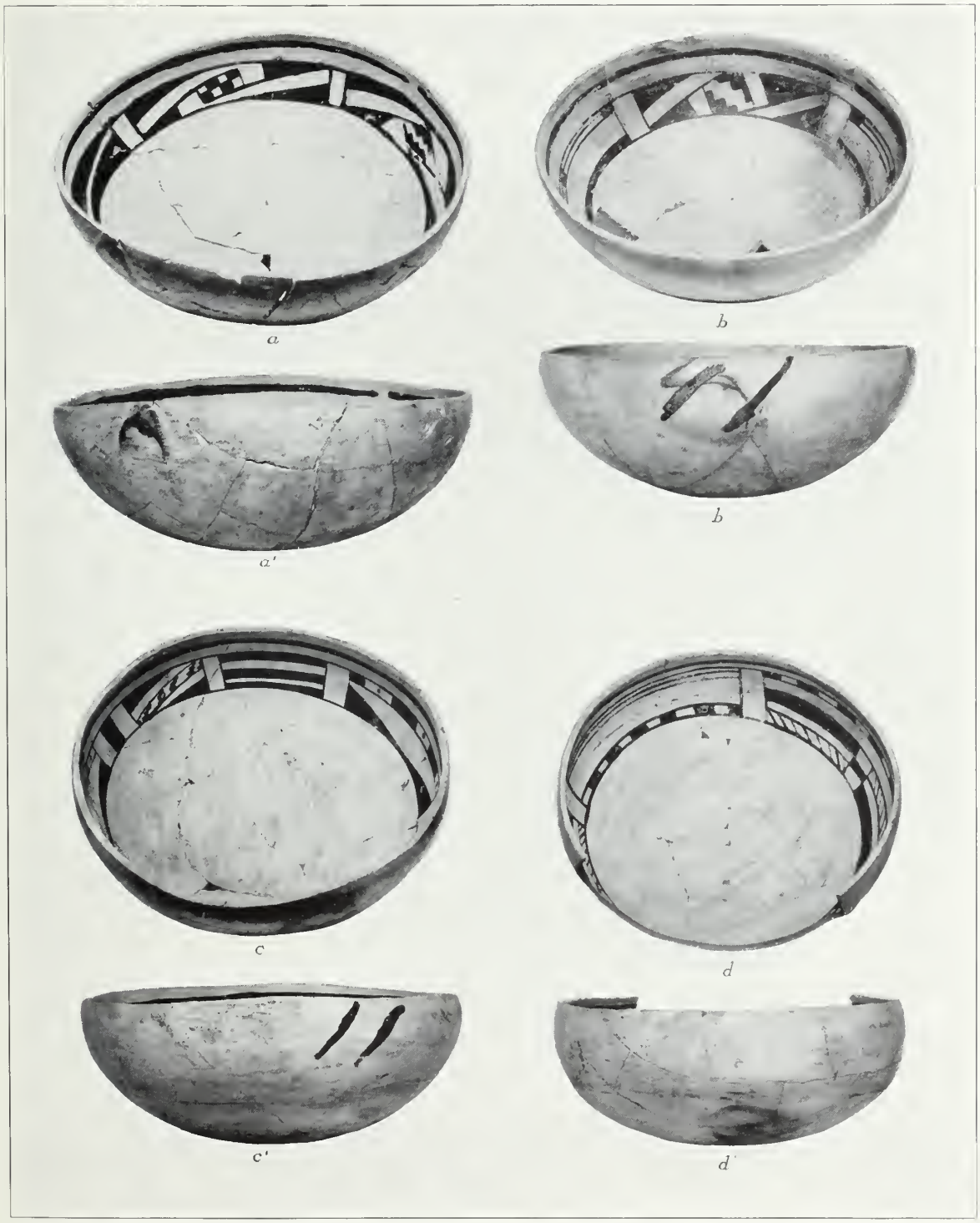


Fig. 34. Glaze I Yellow. Bowls with band decoration. (Diam. of *a*, 13¼ inches)

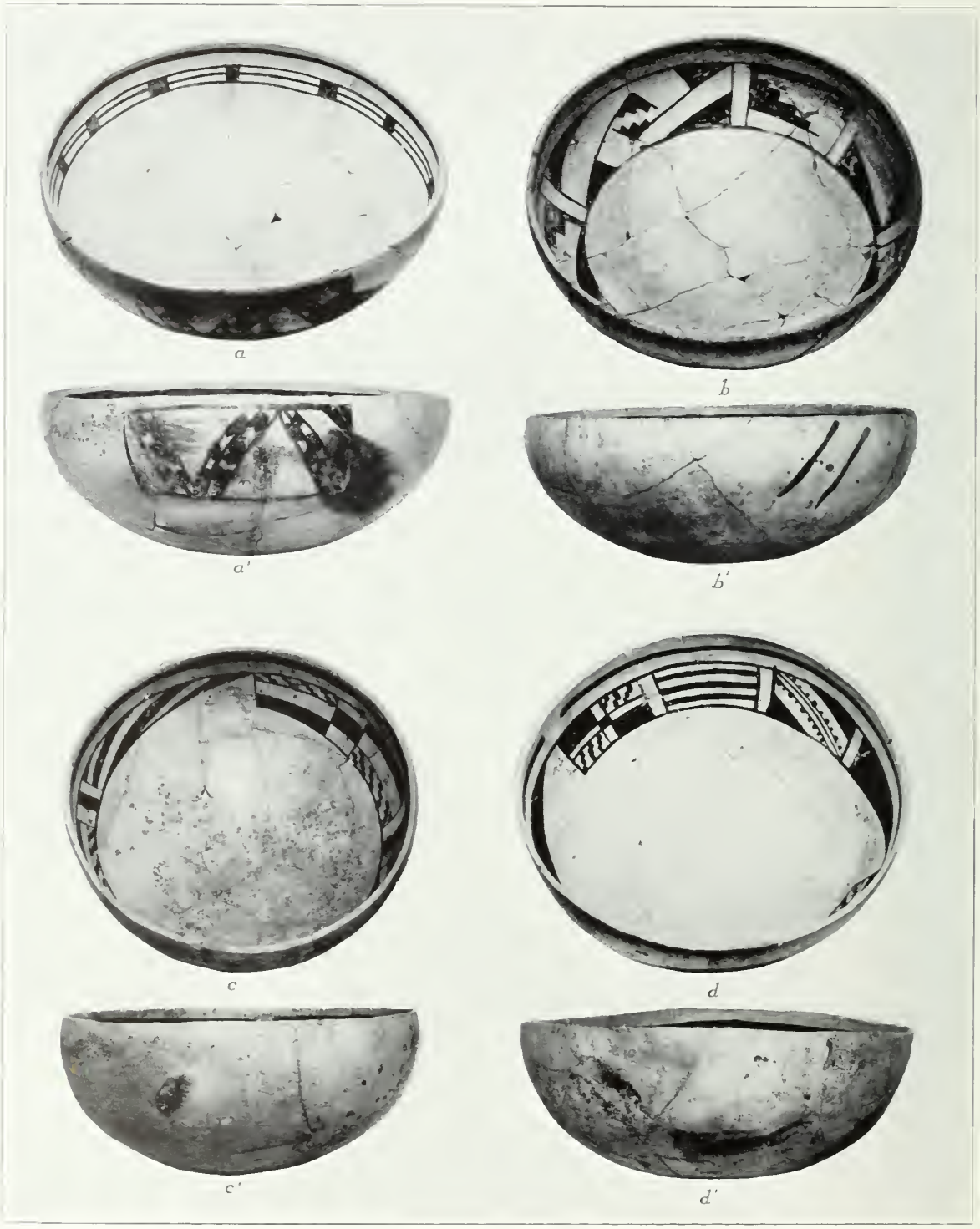


Fig. 35. Glaze I Yellow. Bowls. *a:* Narrow band. *b:* Normal band. *c*, *d:* Pendent triangles. (Diam. of *a*, $12\frac{1}{4}$ inches)

4⅞; average *orifice-depth index* is .41 (extremes are .37 and .48, three examples of each). *Capacity* averages about 6 dry quarts (6.6 litres). *Thickness* of bowl walls is always close to 3/16 of an inch; extremes noted are 5/32 and 9/32 of an inch.

SMALL BOWLS (fig. 32, *b*). Specimens run from 6½ to 8 inches in diameter, with an *orifice-depth index* of about .44; *capacity*, 1 to 2 dry quarts (1.1 to 2.2 litres).

OLLAS

Our knowledge of the shape of the Glaze I Yellow olla is limited to what can be derived from sherds, and small sherds at that, for although this vessel appears to have been quite as common in the yellow type of Glaze I as it was in the red, we failed to recover even any sizable fragments. Such material as we have suggests that in form and capacity the two sorts of ollas were closely similar (see fig. 1, *d*). Mr. N. C. Nelson has very courteously permitted me to illustrate (fig. 6, *d*) a Glaze I Yellow olla excavated by him at Pueblo Cieneguilla.

GENERAL DECORATIVE FEATURES

COLORS. Brownish to black glaze on light backgrounds. In a small percentage of bowls a polychrome effect was achieved by the use of red fillings (fig. 59, *e-k*).[1] Ollas were sometimes also enriched with red fillings, as well as by slipping the neck red.[2]

SLIP EXTENT. *Bowls:* light-colored slip always covers the entire interior. Often the whole exterior is slipped, but usually with a thinner, often a "washy," coat. About 50% of the bowls are only slipped on the upper part of the exterior; the bottom, in such cases, is left unslipped, when it has the brownish-red color of the paste. Rarely (25 sherds, no complete pieces) the whole exterior is slipped with red. These specimens are probably comparable to Mera's "San Clemente Glaze-polychrome." *Ollas:* although the data are very poor, because of the lack of complete vessels, it seems that, as in bowls, the slip sometimes covered the whole exterior; sometimes, however, the bottom was slipped red or left in the paste. The interior of the neck was slipped as far down as the outward spring of the body.

ZONES OF DECORATION. *Bowls:* exterior decoration, in the form of dashes (figs. 34, *b'*, *c'*; 35, *b'*; 46, *a'*) and crosses close below the lip, is definitely commoner than in Glaze I Red. A few more ambitious ornaments also occur (fig. 35, *a'*), but the principal field is the upper part of the interior. Designs seldom invade the interior bottom (but see figs. 46, *b*; 51). Lip decoration by dotting, or otherwise, is absent. The inner surface of the rim, in the few sherds with outcurved rim, bears vertical lines, a zigzag, or a series of small crosses (fig. 59, *c*, *d*). *Ollas:* upper body from a little above the shoulder to the base of the always undecorated neck. The lip is not ornamented.

[1] Mera calls such pieces "Cieneguilla Glaze-polychrome."

[2] It is impossible to give even approximately accurate figures as to the prevalence of polychromy. It was surely infinitely rarer than the thirty or forty sherds in the collection would indicate, for these represent every example found during the field examination of thousands of Glaze I Yellow fragments.

BOWL INTERIOR DECORATION

The following methods of bowl decoration are found:

Bands	29
Narrow bands	3
Pendent triangles	20
Pendent rectangles	1
Lunes	14
All-over patterns	6
Aberrant patterns	1
	74

Although the above figures would seem to show that the band is of relatively less importance than in Glaze I Red (39% as against 56% for Red), the sherds indicate that it really held a strong preponderance over Pendent Triangles and Lunes. Possibly bowls bearing the latter patterns were in favor for mortuary use (our whole specimens emanate almost exclusively from graves).

BAND PATTERNS

Area covered. *Bowls:* interior from just below the lip downward for 2 to 4½ inches (see fig. 34). *Ollas:* upper body from at, or just above, shoulder to base of neck (fig. 6, *d*).

Framing. While only about 60% of Glaze I Red bands on bowls were provided with a heavy upper framer, this feature is present on over 95% of the Glaze I Yellow examples (figures from complete vessels and sherds). It is a broad (¼ to ½ inch), well-drawn line, placed ⅜ of an inch to 1 inch below the lip and usually a somewhat greater relative distance above the band proper. It contains the exit space even more regularly than does the upper framer of Glaze I Red, there being but two unbroken framers in the collection (fig. 38, *g*, *h*). A lower framer is rare; where it does appear (as in figs. 37, *e;* 38, *a*) both it and the upper one are narrower than usual (this is also true of Glaze I Red). The band itself is margined above and below by a thin banding line.

Paneling. All broad bands seem to have been paneled. I can find no evidence in the large sherd collection of such unpanelled designs as occasionally are seen in Glaze I Red (cf. fig. 18). The paneling systems are the same as those of Red: a heavy vertical bar between narrow engaged paneling lines (fig. 38); or a vertical open space between narrow engaged paneling lines (figs. 36, 37). An odd variant of the bar treatment is seen in fig. 38, *f;* the bar, in that case, instead of being solid black, is embellished with stepped lines. Four-panel division is conventional; as is the alternation of two unlike panels: A,B,A,B. There is one instance (fig. 38, *h*) of two long bar-divided panels, each of which contains three minor panels separated by open spaces; this arrangement may be expressed by the formula: A (a, b, c), A (a, b, c). The band with four unlike panels: A,B,C,D (fig. 36, *d*) is apparently unique; the irregularly spaced band in fig. 37, *f* seems to be an example of beginner's work.

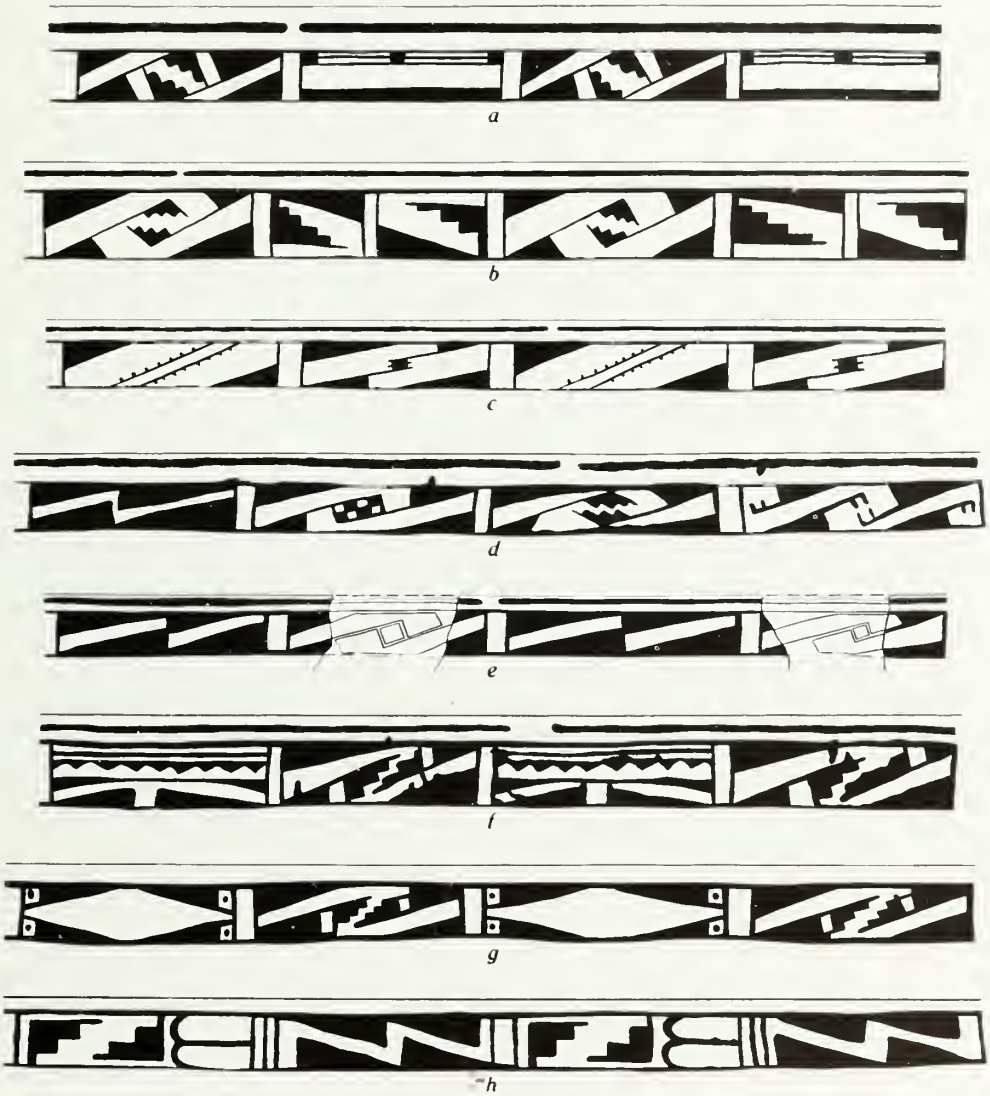


Fig. 36. Glaze I Yellow. Band patterns, paneling by vertical open space. (1/8)

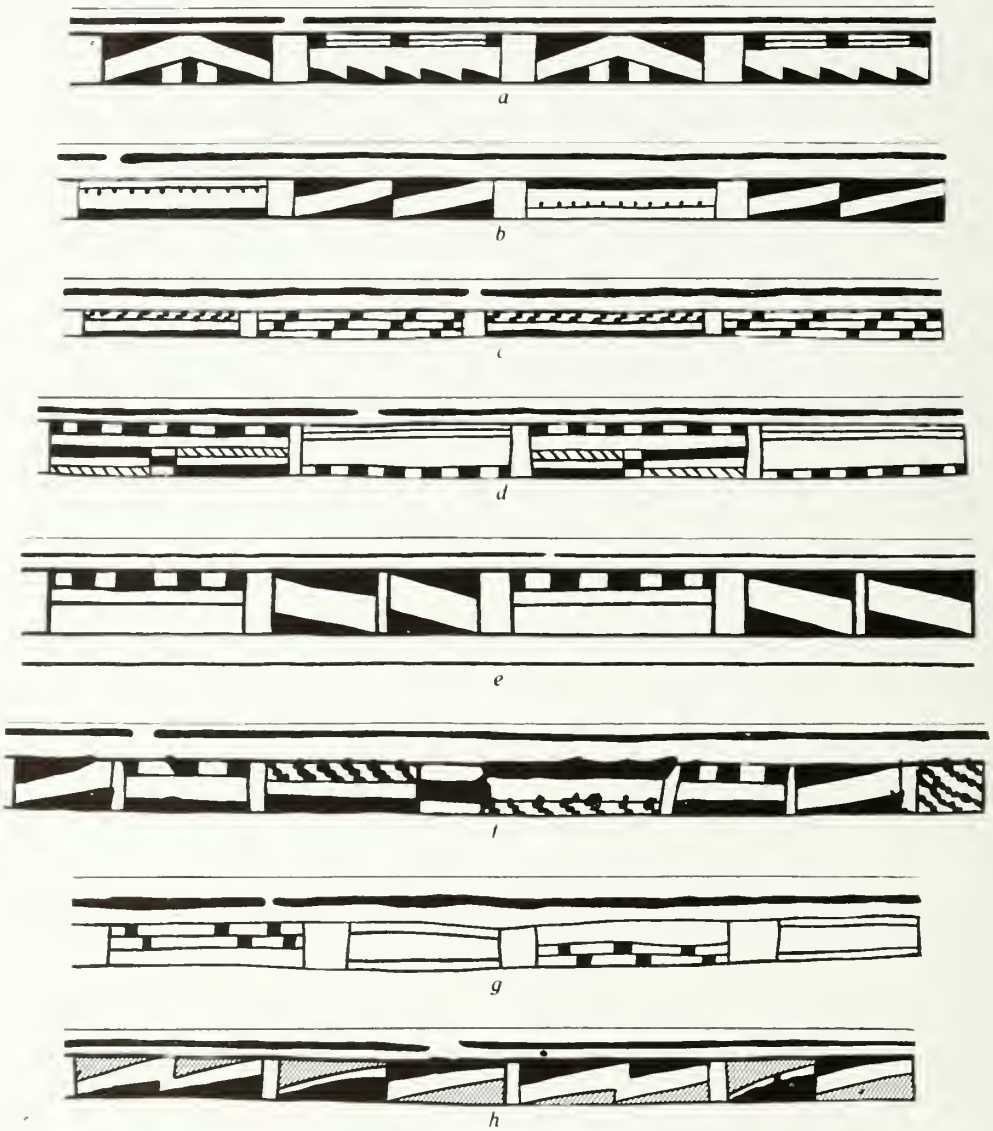


Fig. 37. Glaze I Yellow. Band patterns, paneling by vertical open space. Band *h* is from the only complete polychrome Glaze I Yellow bowl in the collection (the red fillings are indicated by hachure). (1/8)

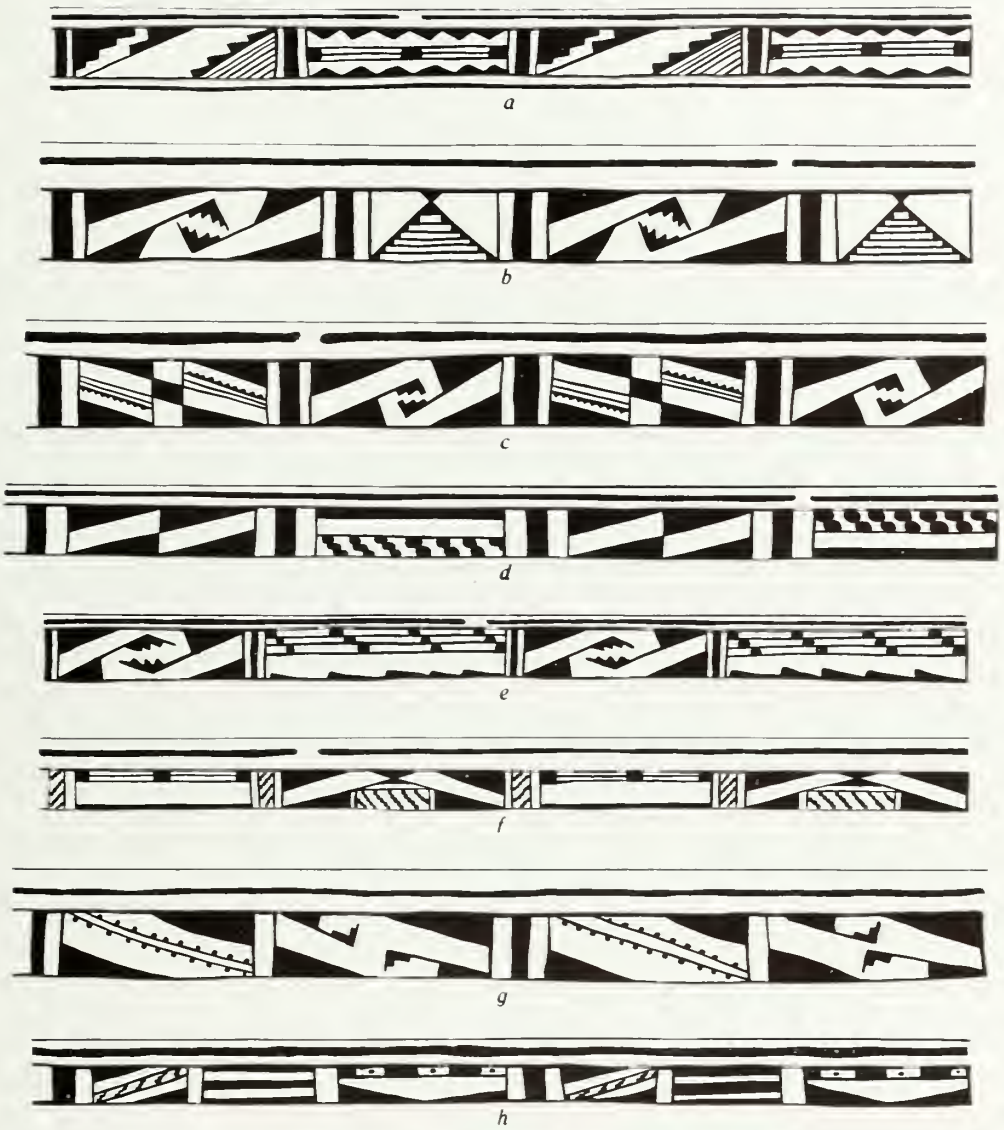


Fig. 38. Glaze I Yellow. Band patterns, paneling by heavy vertical bar. (1/8)

Panel layout. In general, the panels are subdivided and filled in much the same manner as are those of Glaze I Red; most of the observable differences are very likely due to the accidents of collecting, although the greater variety of Glaze I Yellow treatments may be significant. The following methods of subdivision appear (asterisks indicate absence from the Glaze I Red collection):

Horizontal line (fig. 39, *a*)
Double cross (fig. 39, *b*)
Oblique line (fig. 39, *d*)
*Vertical-oblique cross (fig. 39, *e*)[1]
*Double vertical-oblique cross (fig. 39, *c*)
Corner lines (fig. 39, *g*)
Stalks for opposed elements or slung rectangle (fig. 39, *h*)
Triangle (fig. 39, *i*)
*Unbalanced X (fig. 39, *l*)
*Corner-to-corner curve (fig. 39, *k*)
*Diamond (fig. 39, *j*)

Horizontal line (fig. 39, *a*). The commonest of all treatments. A single line drawn close to the top of the panel occasionally produces this division (figs. 39, *a*; 40, *k*); usually, however, there are two lines, one near the top, another near the bottom (fig. 40, *a*, *b*). Either method results in the creation of narrow sub-fields, one or more of which, in any given panel, may be filled solidly with black to give the appearance of heavy lines (fig. 40, *b f*). Stepped lines are also used (*c*); and in a great many cases a narrow sub-field is occupied by a strip of plain (*i*, *j*) or dotted (*k*, *l*) checkerboard. As in Glaze I Red, there is often a division into a narrow and a broad sub-field; in such instances the broader one is normally treated as a panel in one or another of the conventional styles (see figs. 41, *d*; 42, *g*, *h*; 43, *k*).

Double cross (fig. 39, *b*). Less common, apparently, than in Glaze I Red; the simple cross (fig. 12, *b*), it may be noted, which was rare in Red, does not appear at all in our collection of Yellow. Paired horizontal and vertical lines cut the panel into four rectangles and a small central square. The rectangles are filled with black or with stepped lines, the two methods usually alternating in any given panel (fig. 41, *a*, *b*). The central square is always black.

Oblique line (fig. 39, *d*). Less common than in Red. Triangular areas are produced by the primary division of the panel by a series of two or three lines drawn between diagonally opposite corners. Dots fringe the lines (fig. 42, *a*, *b*) or are placed between them (*c*); the ubiquitous stepped line may also occupy the space between two such lines (*d*). The corners of the panel are habitually cut off and blacked; they are apparently seldom decorated with keys or otherwise, as was sometimes the practice in Glaze I Red (cf. fig. 15, *e*, *g*, *h*).

Vertical-oblique cross (fig. 39, *e*). A very common method of subdivision. A vertical line cuts the panel into two equal parts; a second line runs between diagonally opposite corners, bisecting the first line. The two triangular fields thus formed

[1] Occurs in Glaze I Red in double form only (see fig. 15, *m*, *n*)

are filled with black and the remaining two corners of the panel are cut off and also blacked. This process reserves (i.e., leaves in the background) two oblique parallelograms (fig. 42, *f*). A somewhat similar effect is often gained by drawing pairs of opposed right triangles within the panel (figs. 39, *f*; 42, *h*, *k*, *l*; the reserved space is then continuous.)

Double vertical-oblique cross (fig. 39, *c*). The fact that there are two examples of this method of subdivision on whole bowls (figs. 38, *c*; 41, *e*) and some probable cases on sherds, makes it seem probable that it is not merely a faulty

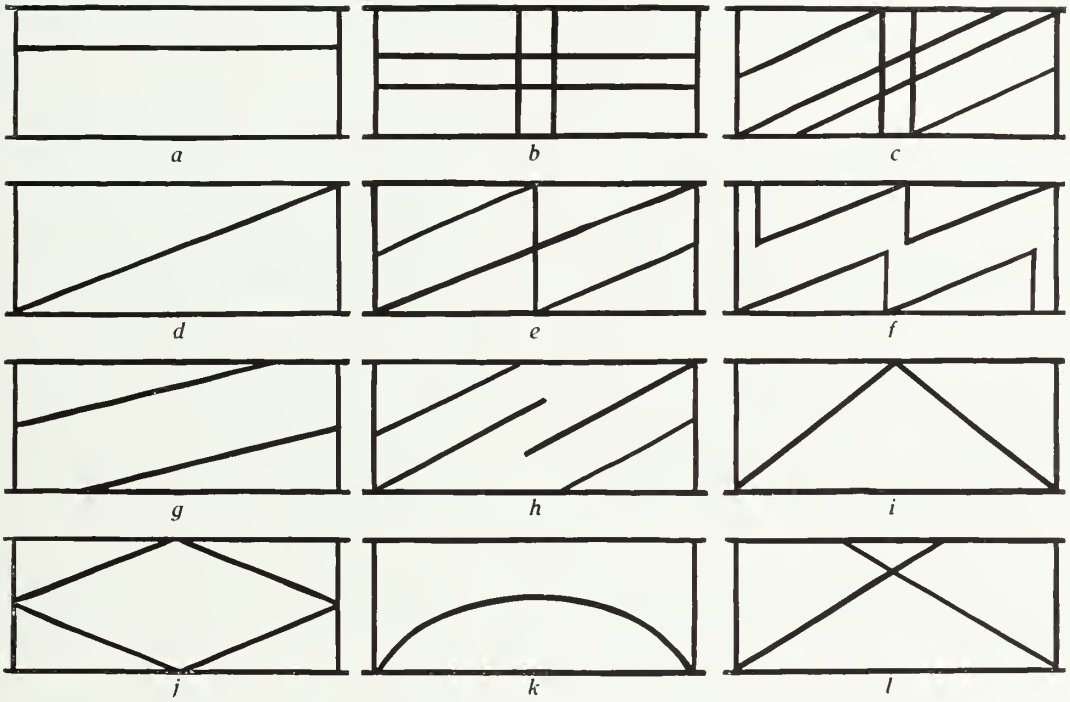


Fig. 39. Glaze I Yellow. Methods of panel subdivision. *a:* Horizontal line. *b:* Double cross. *c:* Double vertical-oblique cross. *d:* Oblique line. *e:* Vertical-oblique cross. *f:* Double triangle. *g:* Corner lines. *h:* Stalks for opposed elements or slung rectangle. *i:* Triangle. *j:* Diamond. *k:* Corner-to-corner curve. *l:* Unbalanced X. (Diagram)

rendering of the double cross, from which it differs only in that one of the sets of paired lines connects diagonally opposite corners of the panel rather than the middle of the panel's shorter sides. There is thus obvious analogy to the vertical-oblique cross.

Corner lines (fig. 39, *g*). Uncommon. Two opposite corners of the rectangular panel are cut off obliquely by parallel lines and the triangular spaces so enclosed are filled with black. There is but a single instance (fig. 42, *i*) of the common Biscuit practice of reserving a rectangle in the right-angle of a black triangle (Vol. 1, fig. 60);

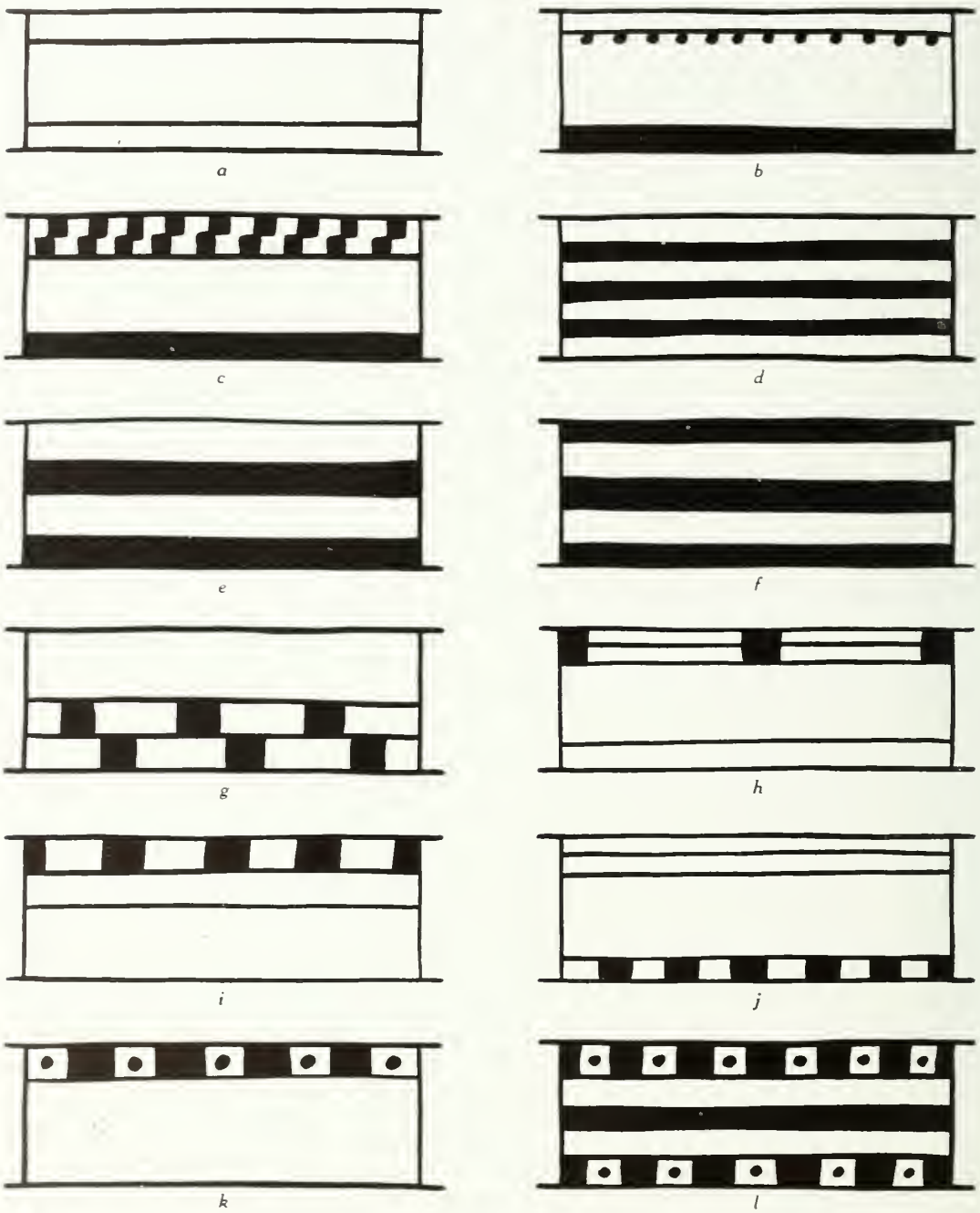


Fig. 40. Glaze I Yellow. Panels subdivided by horizontal lines.

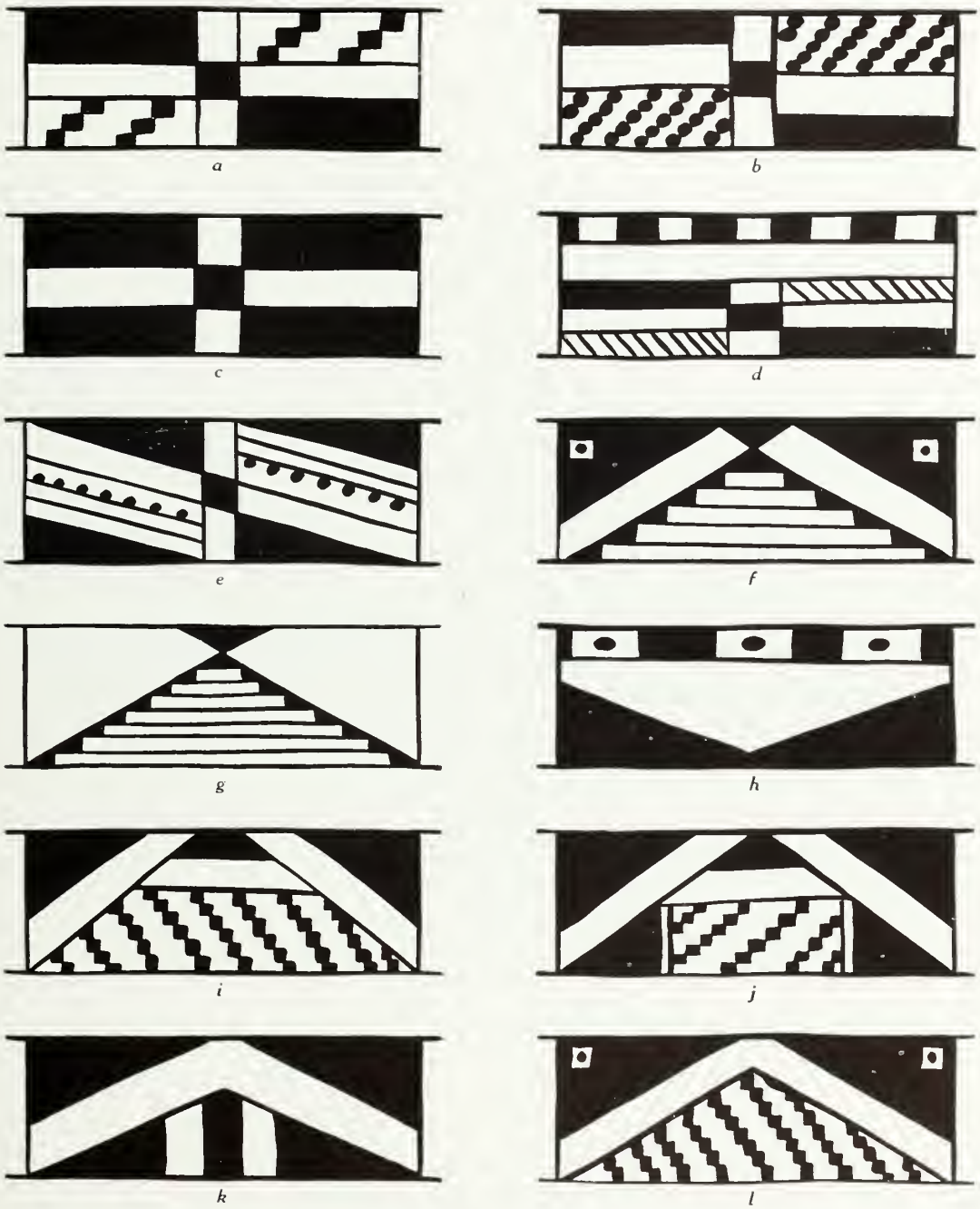


Fig. 41. Glaze I Yellow. Panel subdivision. *a-d:* Double cross. *e:* Double vertical-oblique cross. *f, g:* Unbalanced X. *h-l:* Triangle.

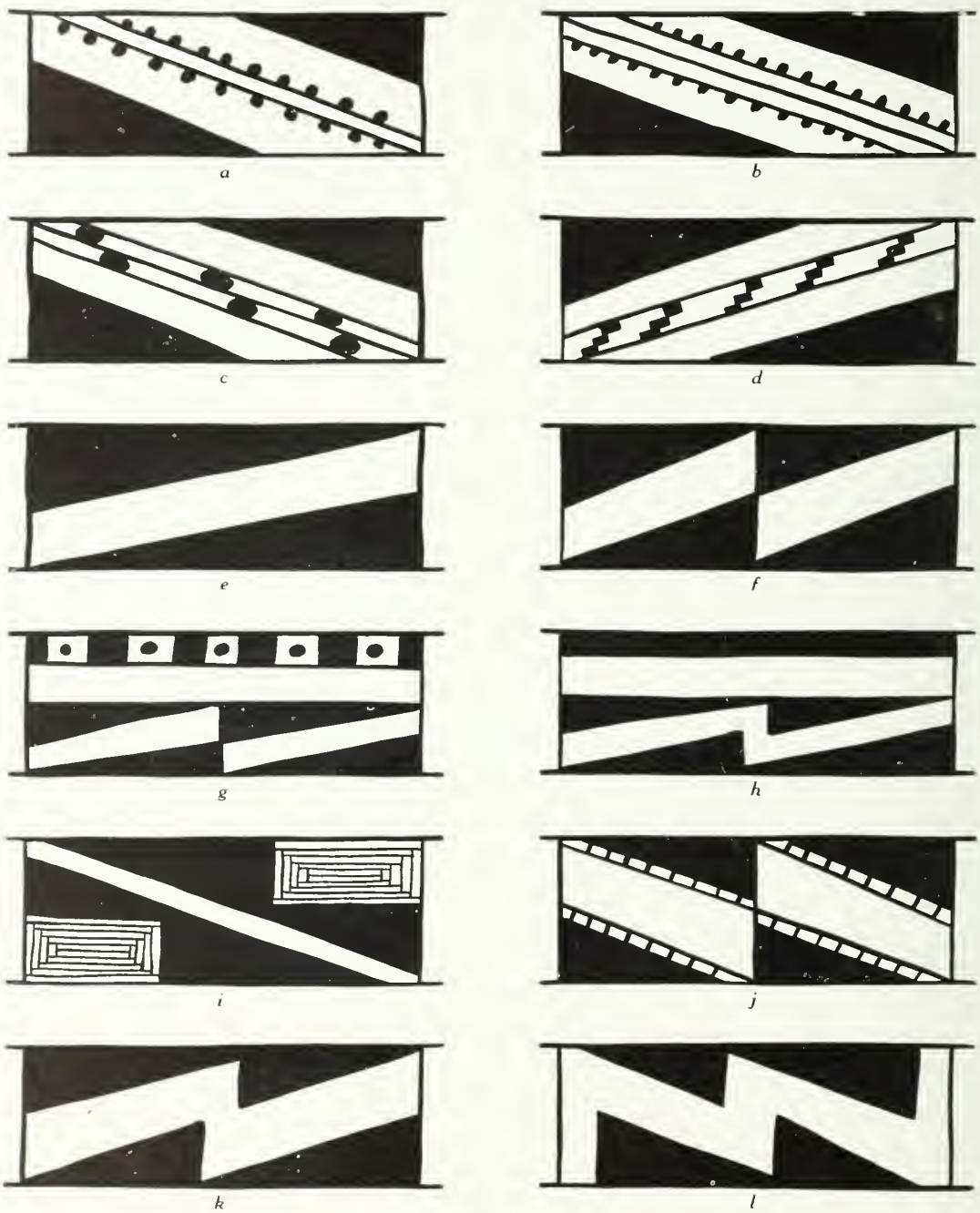


Fig. 42. Glaze I Yellow. Panel subdivision. *a-d:* Oblique lines. *e, i:* Corner lines. *f, g, j:* Vertical-oblique cross. *h, k, l:* Double triangles.

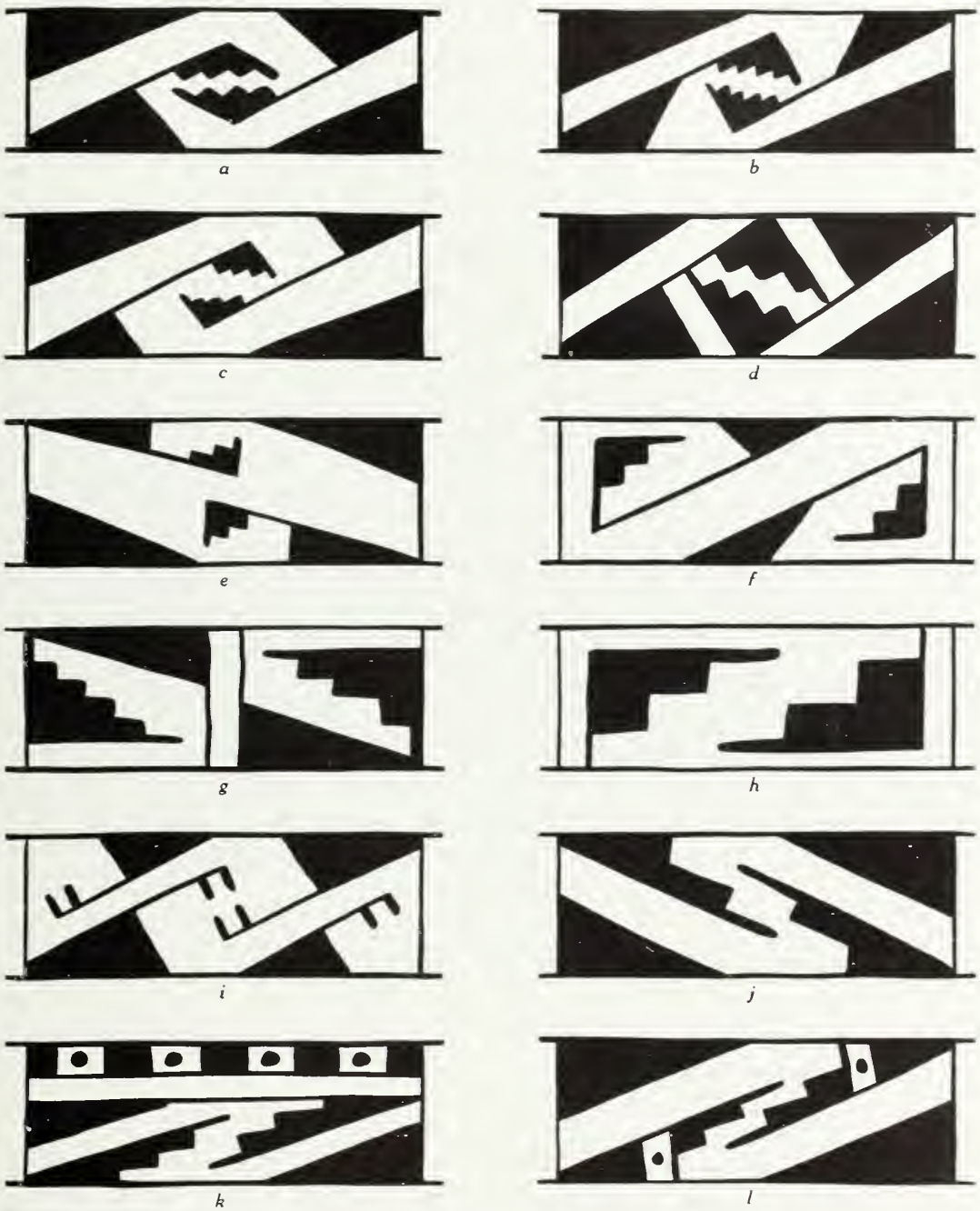


Fig. 43. Glaze I Yellow. Panels containing stalked key figures with base (*a-g*); stalked key figures without base (*h*); birdlets (*i*); oblique unstalked key figures (*j-l*).

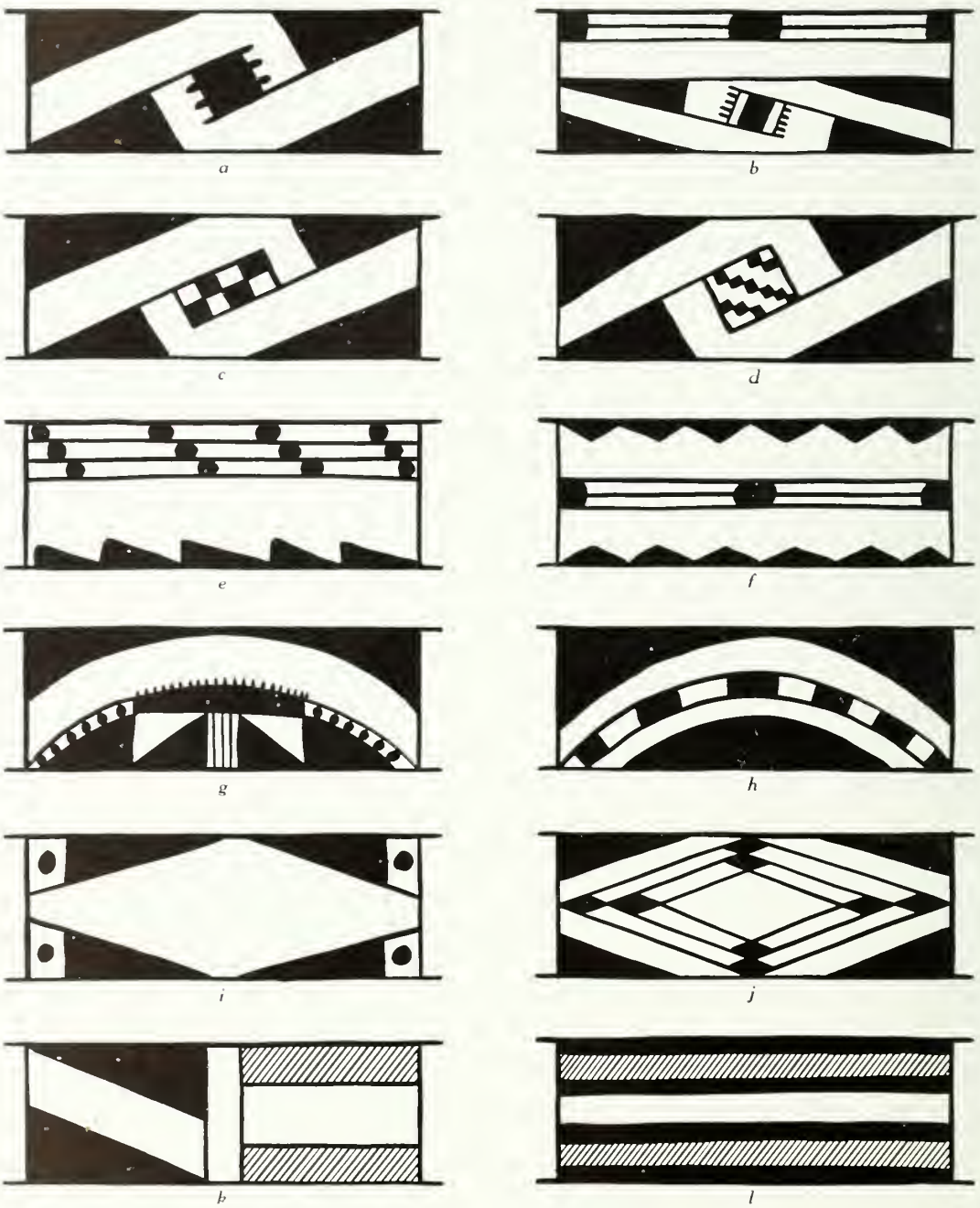


Fig. 44. Glaze I Yellow. Panels containing the slung rectangle (*a-d*); panels with horizontal line subdivision and small triangles in series (*e*, *f*); panels subdivided by corner-to-corner curve (*g*, *h*); diamond (*i*, *j*); polychome panels (*k*, *l*—red indicated by hachure).

the rectangle, in this Glaze I Yellow example, is cribbed (see fig. 56, below), a common Biscuit device, but one never seen, as far as I am aware, in the small reserved rectangles of the Biscuit triangle.

Stalks for opposed elements or the slung rectangle (fig. 39, *h*). Abundant. The framework is exactly the same as in Glaze I Red: two parallel lines emerge from diagonally opposite corners at such an angle that they pass each other. They serve as stalks for stalked key figures with base (fig. 43, *a-e*), as the back-line for oblique unstalked keys (*j-l*), and as supports for the slung rectangle (fig. 44, *a-d*) The corners of the panel are habitually cut off and filled with black.

Triangle (fig. 39, *i*). Commoner than in Glaze I Red. Lines from adjacent lower or (much more rarely) upper corners of the panel, converge to meet at the middle of the opposite side (fig. 41, *i*, *j*) or slightly below the middle (*k*, *l*—this arrangement has not been found in Glaze I Red.) The resultant large isosceles triangle is filled with stepped lines; its corners are often blacked. The two remaining corners of the panel were blacked, sometimes with a dotted "eye" (fig. 41, *l*).

Unbalanced X (fig. 39, *l*). There are three examples from whole vessels (figs. 38, *f*; 41, *f*, *g*) and the sherd collection contains parts of what seem to be others. The layout is much like the triangle, but the two lines meet a little below the upper edge of the panel and are continued to the banding line, forming a second small triangle. Embellishment of the large triangle is by stepped lines or sets of parallel horizontal lines with little step-like fills where they join the sides of the field (fig. 41, *f*, *g*). The small upper triangle is blacked. The unbalanced X may perhaps be an accidental variation of the triangle (fig. 38, *f* and 41, *j* are, for example, almost duplicates).

Corner-to-corner curve (fig. 39, *k*). Two examples (fig. 44, *g*, *h*). This method of panel decoration is notable as being one of the very few instances of the use of curved lines in Glaze I, either Red or Yellow. It is obviously allied to the triangle. The rather "fussy" treatment of the field in figure 44, *g* is not in the best Glaze I tradition.

Diamond (fig. 39, *j*). Two instances (fig. 44, *i*, *j*). All four corners of the panel are cut off and blacked in, leaving a large diamond-shaped field, which is left open in one case, filled with concentric line-diamonds in the other.

NARROW BANDS

This restrained and tasteful treatment, which leaves most of the bowl interior unornamented, is rare. We have three whole vessels (figs. 35, *a*; 45) and about a dozen sherds. In the case of the smaller sherds, however, it is not always possible to be certain that such decoration as is preserved is not merely the upper part of a broader band.

Area covered. The extreme upper part of the bowl interior.

Framing. A single heavy upper framer with exit space. In one specimen (fig. 45, *b*) there is a narrower lower framer.

Elaboration. As the illustration (fig. 45) shows, the bands are extremely simple: a couple of lines, the lower one dotted (*a*); a strip of dotted checkerboard (*b*);

three lines with widely-spaced squares (*c*—the vessel illustrated in fig. 35, *a*). There are sherds which suggest that some bowls were even more chastely decorated with one or two plain but well-drawn, lines just below the heavy framer.

PENDENT TRIANGLE PATTERNS

AREA COVERED. Upper part of bowl interior (figs. 35, *c*, *d*; 46, *d*). Does not occur on ollas. The tails of the bird figures which are attached to certain of the triangles sometimes invade the bottom of the bowl (fig. 46, *d*).

FRAMING. A single, heavy upper framer, almost always broken by an exit space. This line is set from ¼ of an inch to 1 inch below the lip. An equal distance below the framer is a single, narrow, unbroken line from which the triangles depend. In one instance (fig. 48, *f*) the narrow line is omitted, and the triangles are applied directly to the broken framer.

STRUCTURE. Exactly like the pendent triangle of Glaze I Red (cf. figs. 19, 20). There is the same, normally dual, arrangement and usually sinistral direction of the hypothenuse. There are in Yellow, however, several bowls with but a single triangle (figs. 47, *g*, *h*; 48, *e*), a very long one, which makes nearly a complete circuit of the vessel.

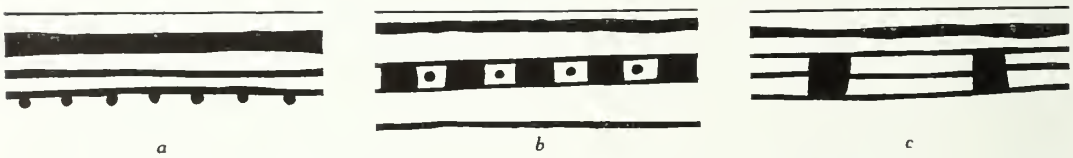


Fig. 45. Glaze I Yellow. Narrow band patterns. (*Ca.* 1/4)

ELABORATION. In the conventional two-triangle patterns each triangle contains two unlike panels, the same panels being repeated in the other triangle. The alternation is therefore the same as in bands: A,B,A,B. Three panels (as in fig. 47, *b*) are rare. The tapering end of the triangle is usually black, but there are a few examples in which it is only partially filled, a longitudinal reserved space being left clear (fig. 47, *d*) or treated with a zigzag (fig. 48, *a*). The very narrow triangles in fig. 49, *b*, *c* are unpaneled.

On the free, or downward-pointing, corner of the triangle there is often perched a bird (fig. 48, *a-e*); less commonly a small three-sided appendage (*f*). The short vertical side of the triangle, which in all our Glaze I Red specimens is unembellished, occasionally bears, in Glaze I Yellow, a key (figs. 47, *g*; 49, *b*, *c*) or some other ornament (fig. 47, *f*, *h*). The two examples in fig. 49, *b*, *c*, which terminate in keys, are unusually delicate and restrained. In this respect they are akin to the narrow bands described above.

PENDENT RECTANGLE PATTERNS

We have but one example (fig. 49, *a*; from a bowl 8¾ inches in diameter). Framing is by the usual heavy, broken line; the rectangular panels hang from a narrow banding line.

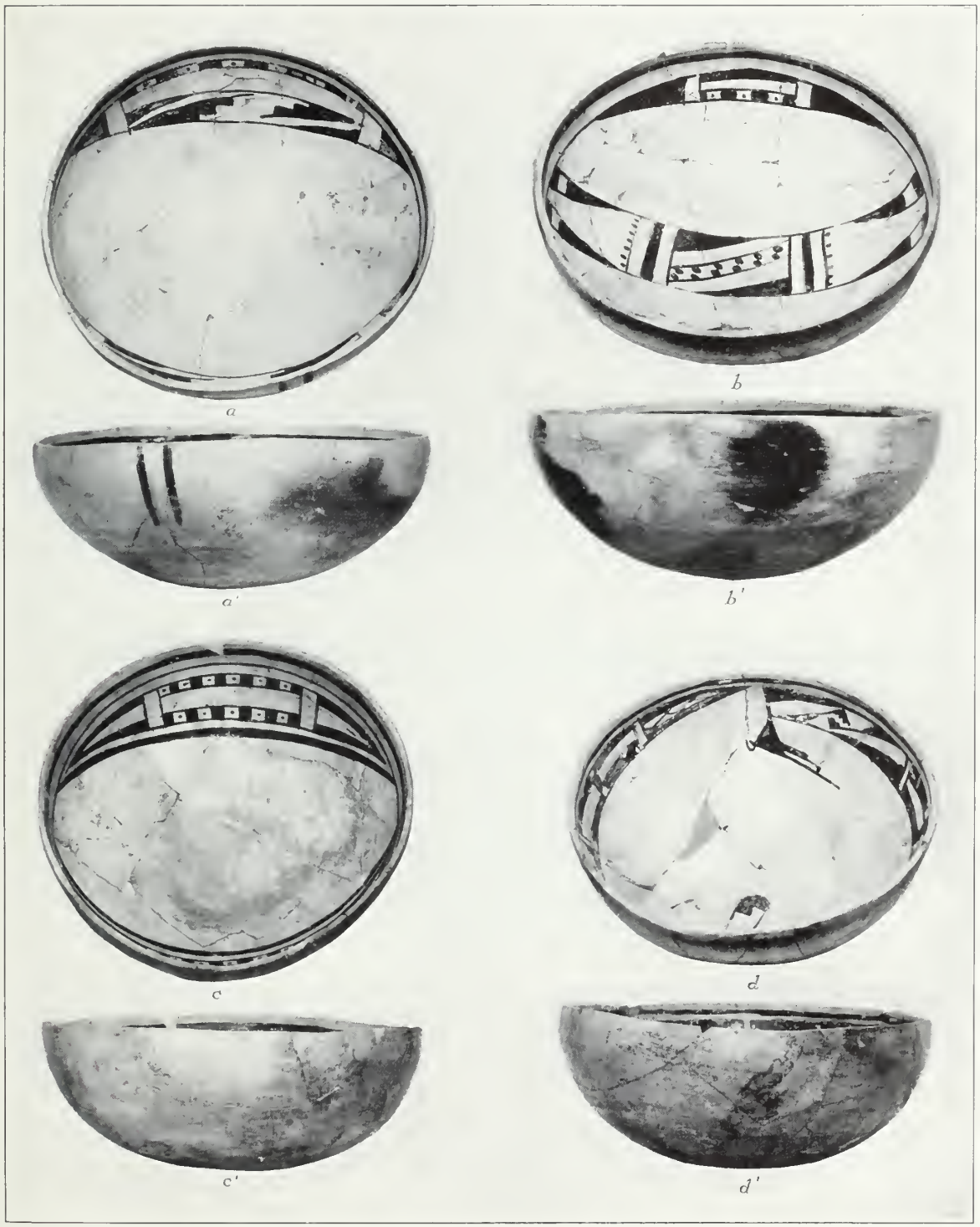


Fig. 46. Glaze I Yellow. Bowls. *a-c:* Lune decoration. *d:* Pendent triangles. (Diam. of *a*, 12½ inches)

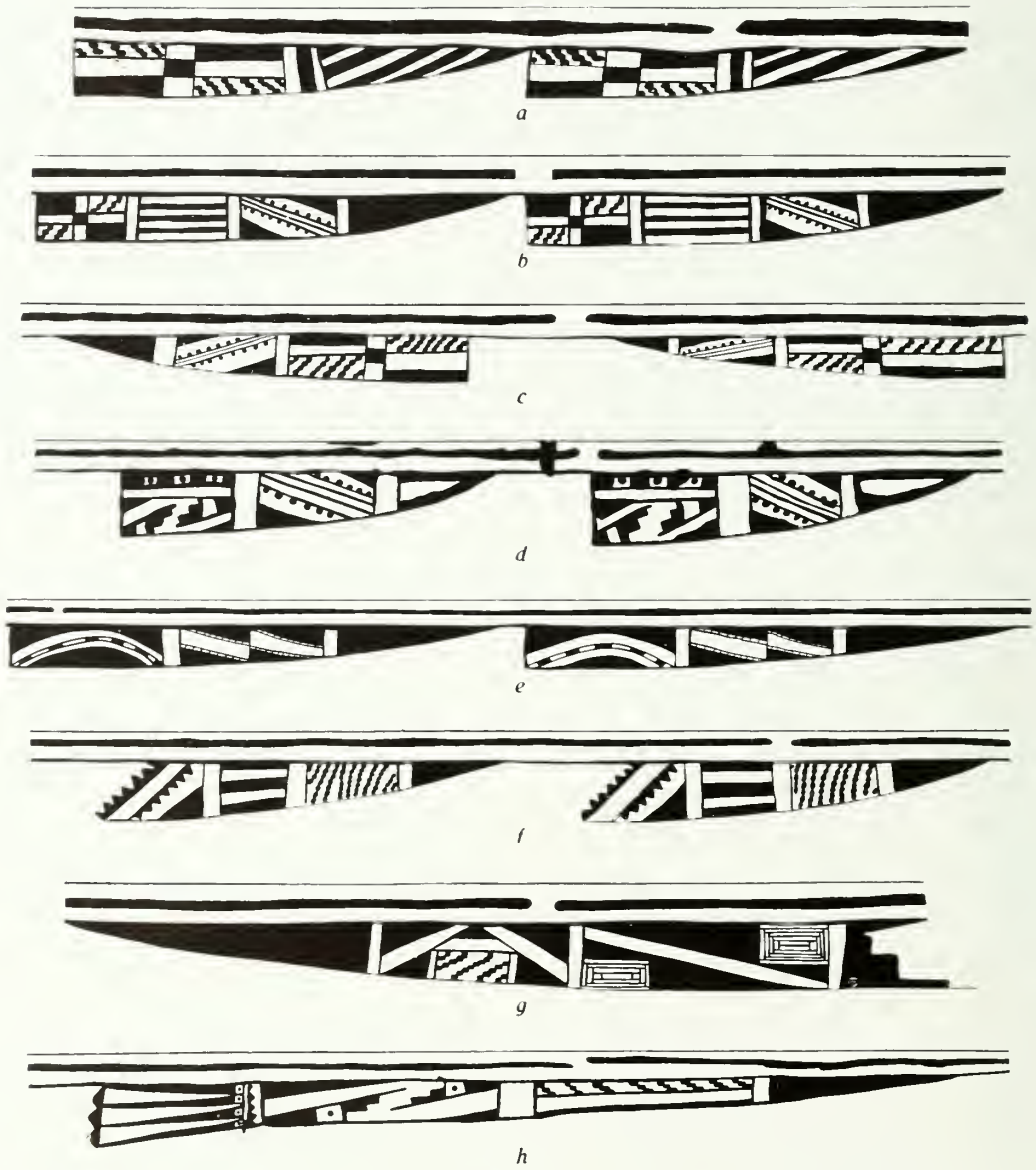


Fig. 47. Glaze I Yellow. Pendent triangle patterns. In *f*, *g*, *h* the short vertical side of each triangle bears an added decoration. (1/8)

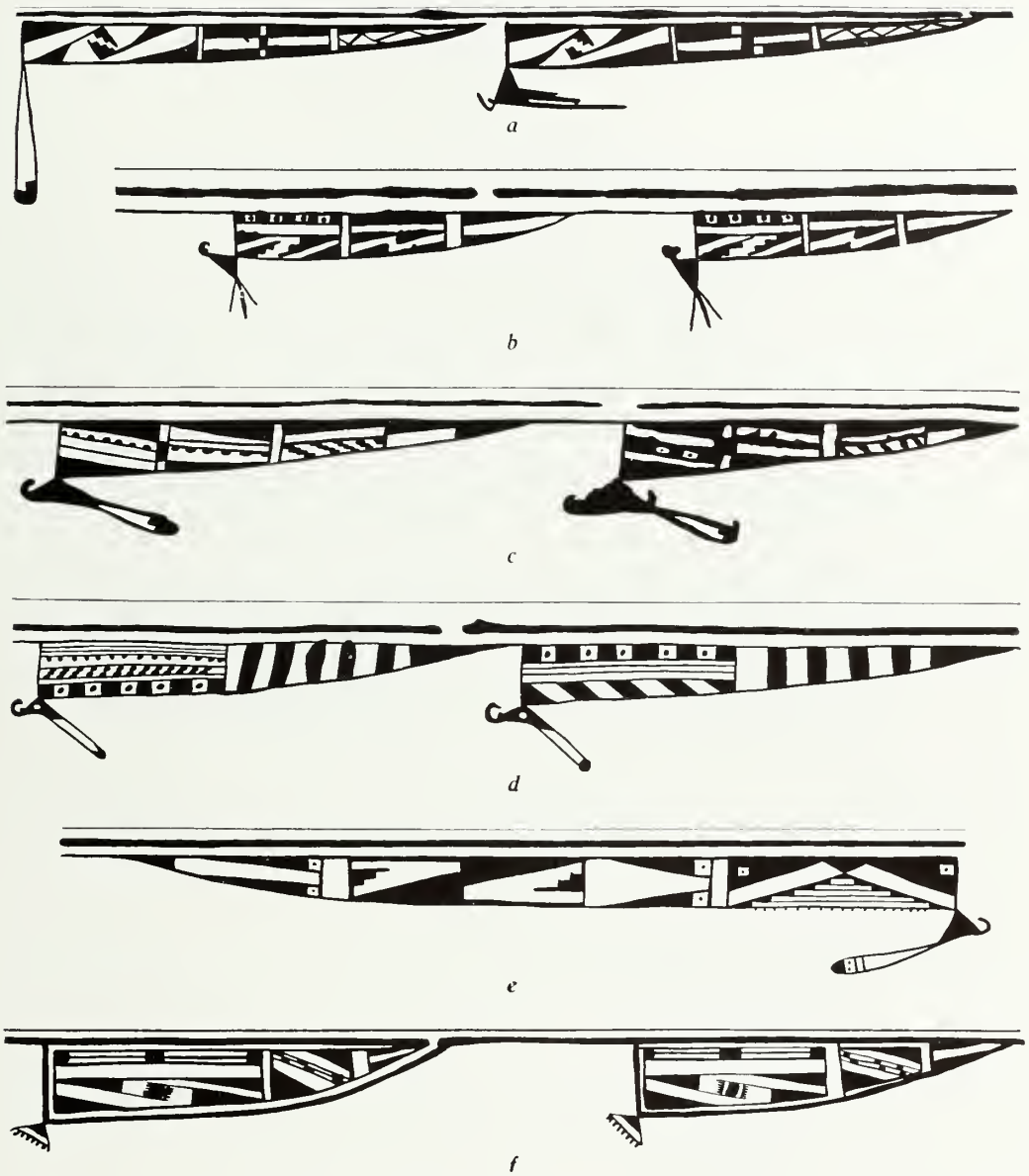


Fig. 48. Glaze I Yellow. Pendent triangle patterns with bird and other figures. The pendent "feather" of *a* is seen in several sherds. (1/8)

LUNE PATTERNS

AREA COVERED. Two elongated fields on opposite sides of the upper part of the bowl interior (figs. 46, *a-c*; 50); for remarks upon the shape of the fields, see p. 26 in the section on Glaze I Red. The fields may or may not join at the ends (see fig. 50).

FRAMING. A heavy upper framer, sometimes unbroken by an exit space. The lunes are attached to a narrow banding line drawn at about the same distance below the framer as the latter is below the lip.

ELABORATION. The influence of band decoration is obvious, the broad central part of each lune being occupied by a single panel of conventional band type, which is separated from the tapering ends by vertical open spaces or by heavy bars in exactly the same way that panels in bands are separated from each other. The ends are either black or, if there is room, lightened by a horizontal reserved space, dotted "eyes," etc. The panels in the two lunes of any given bowl are usually alike (A,A).

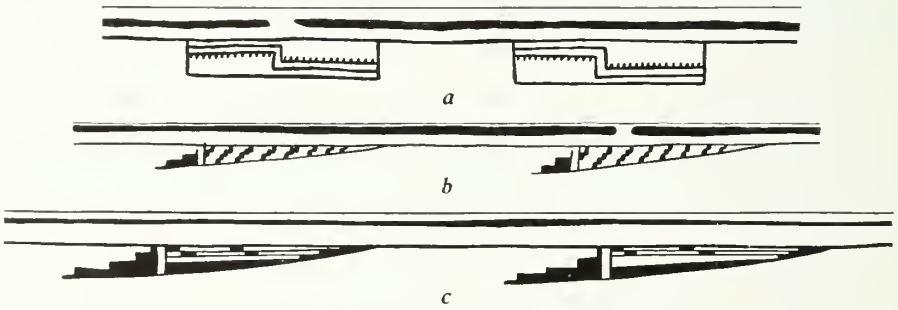


Fig. 49. Glaze I Yellow. *a:* Pendent rectangle pattern. *b, c:* Pendent triangles with key figure terminations. From small bowls. (1/8)

ALL-OVER PATTERNS

AREA COVERED. These very rare patterns invade the interior bottom of the bowl (fig. 51).

FRAMING. Single heavy line, with or without exit space; or narrow band of checkerboarding.

STRUCTURE. The upper part of the bowl is encircled by the above-mentioned strip of checkerboarding (fig. 51, *d, f, g*), or by lunes (*b, c*). The bottom is sometimes crossed by a paneled band (*b, e*), the sherds indicating that this was a not uncommon practice (see sherd *j* in fig. 54); or is occupied by a large figure (fig. 51, *c*) or a pair of figures (fig. 51, *d, g*).

ABERRANT PATTERNS

Among the decorations of the whole bowls there is but one (fig. 51, *a*). It is, strictly speaking, an all-over pattern, but it departs so radically from the canons of Glaze I Yellow as to justify its segregation. The illustration makes clear the bungling

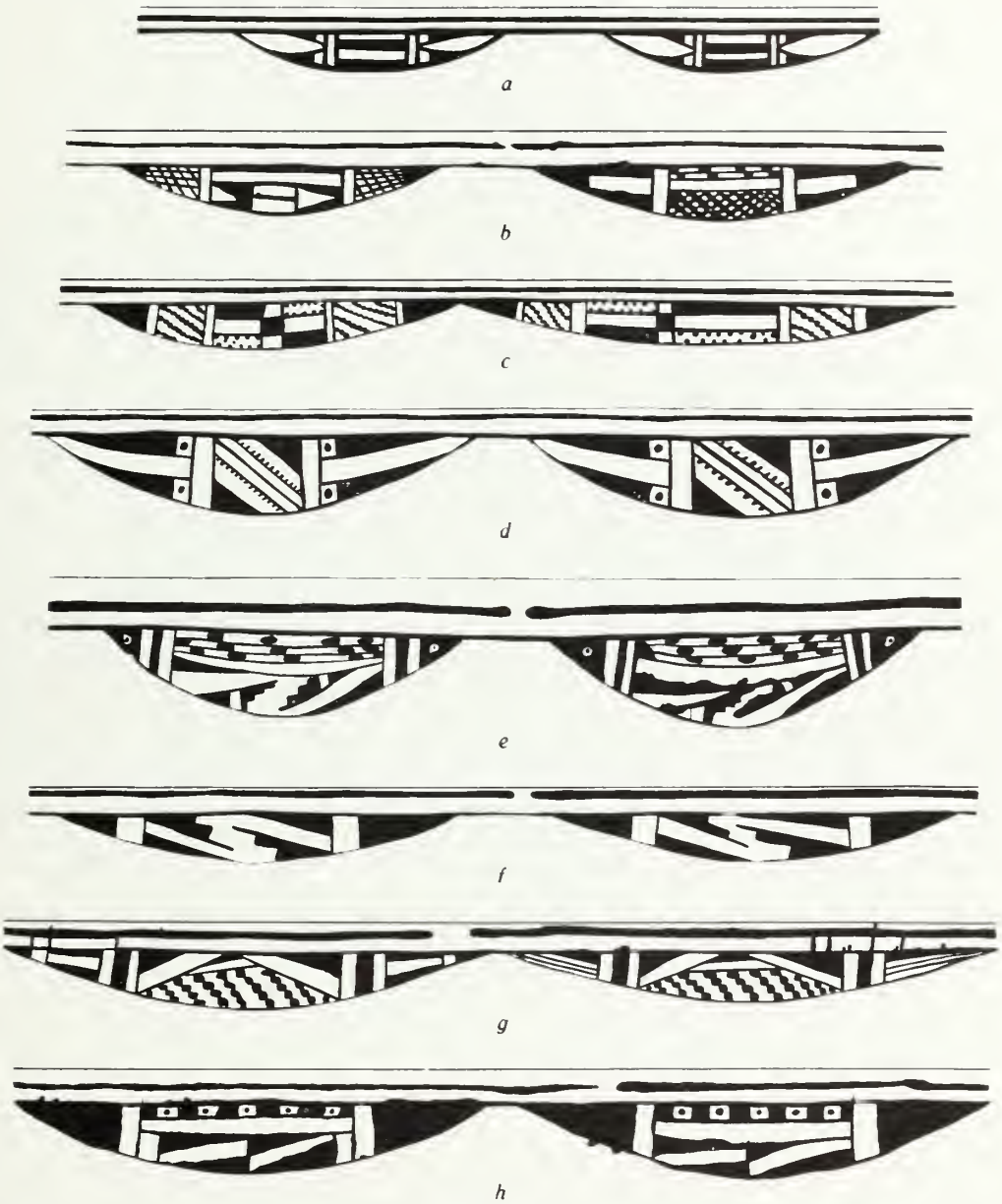


Fig. 50. Glaze I Yellow. Lune patterns. (1/8)

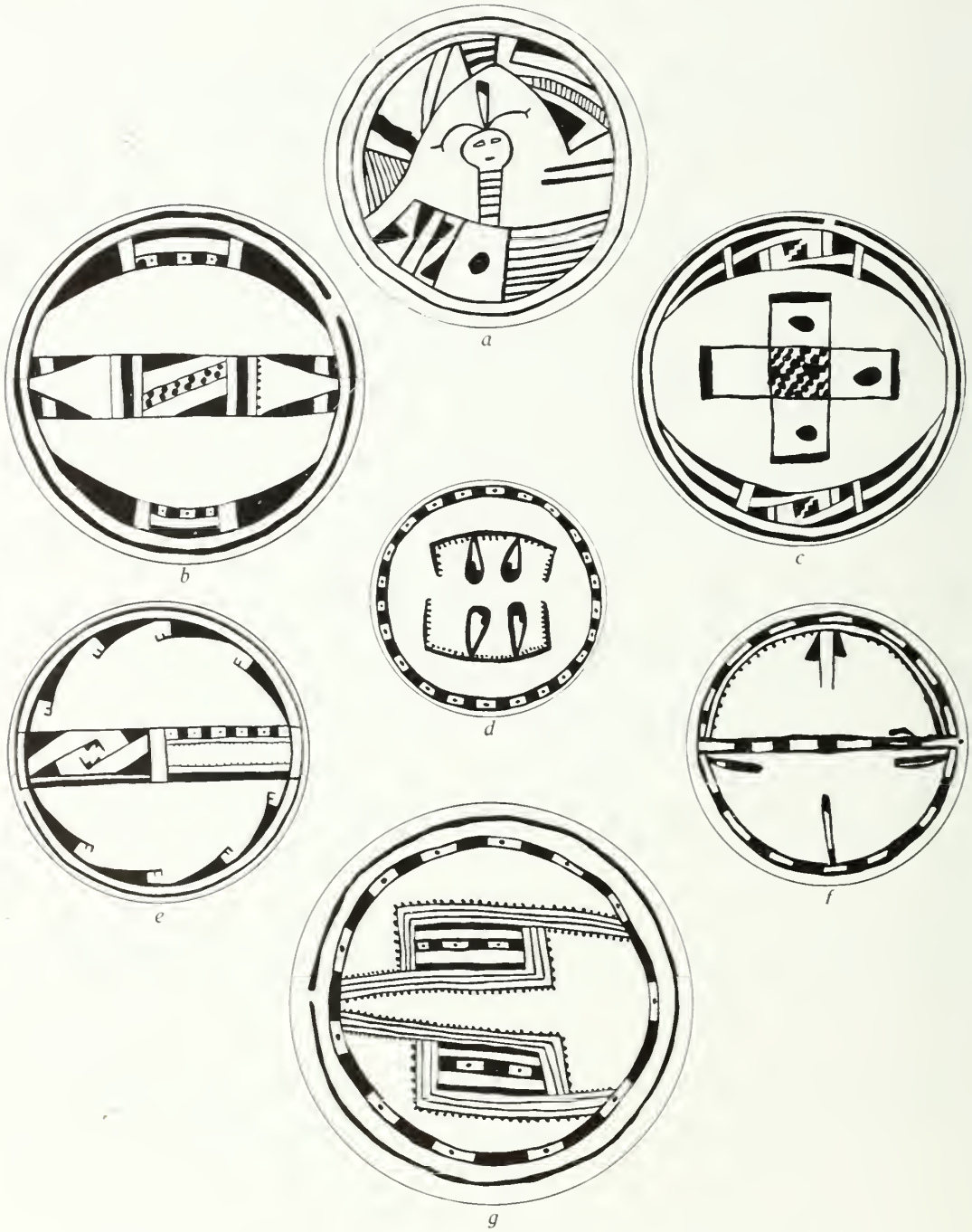


Fig. 51. Glaze I Yellow. Bowls with all-over decoration. (*Ca.* 1/8)

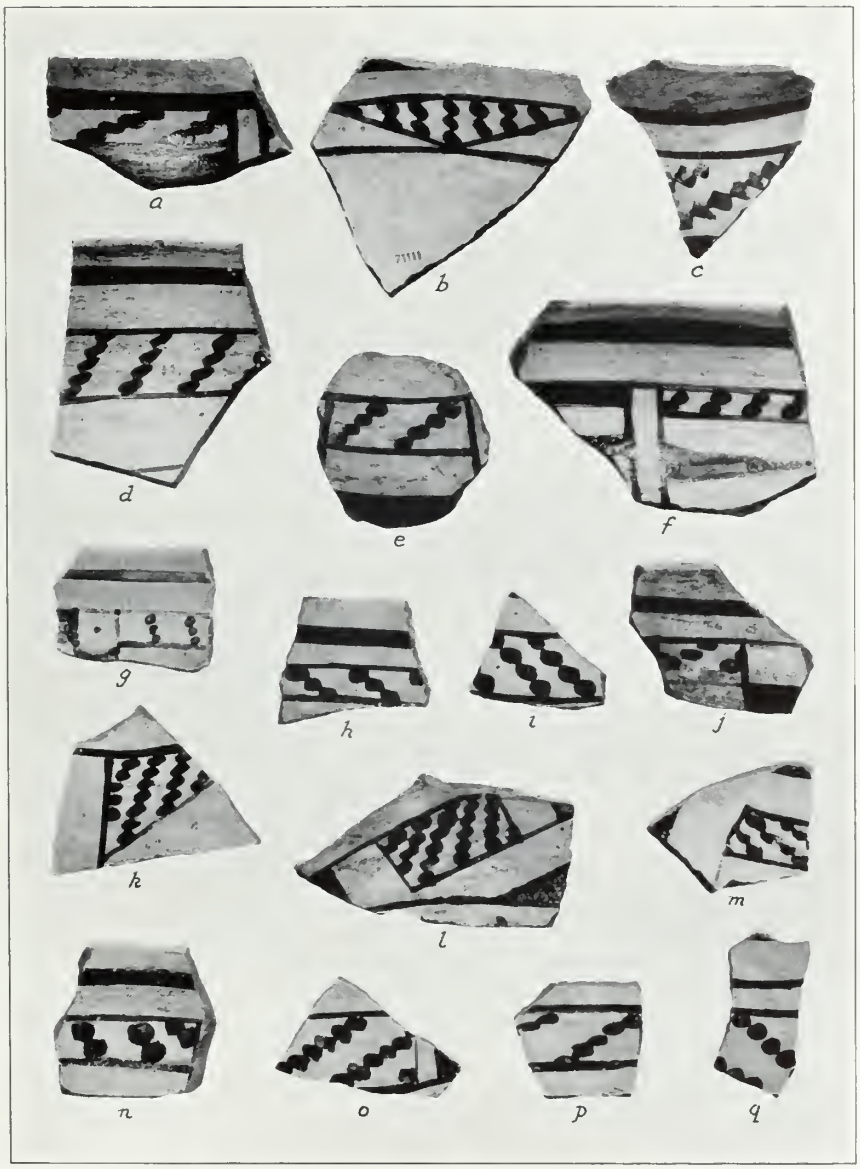


Fig. 52. Glaze I Yellow. Sherds illustrating use of the stepped line. *c*, *e*, *k*, *l*, *q* from ollas, the rest from bowls. (Width of *f* at rim, $3\frac{3}{4}$ inches)

Fig. 53. Glaze I Yellow. Sherds illustrating use of dotted checkerboarding (*a-j*) and rectangular blocking between lines (*k-s*). *h*, *i*, *r*, *s* from ollas, the rest from bowls. (Width of *n*, 3 inches)

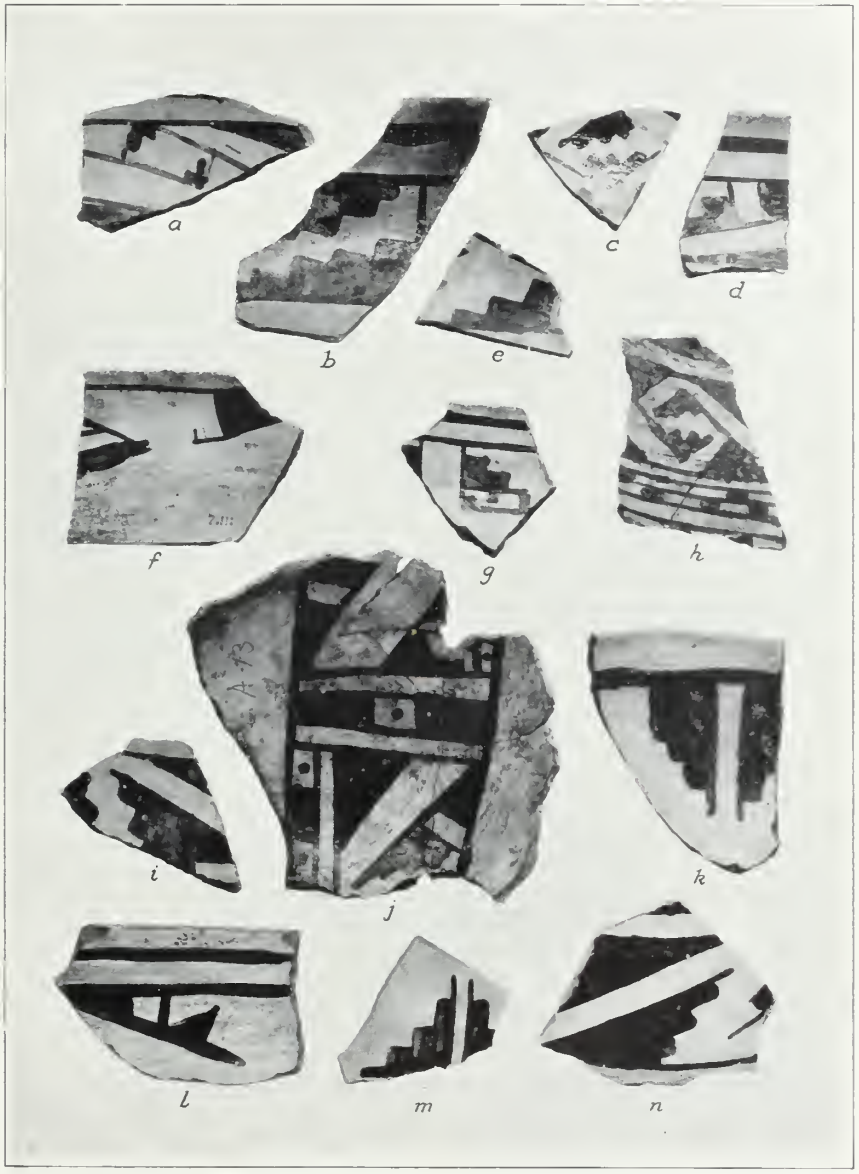


Fig. 54. Glaze I Yellow. Sherds illustrating use of various forms of the key figure. *h*, *n* from ollas, the rest from bowls. (Greatest dimension of *j*, 6 inches)

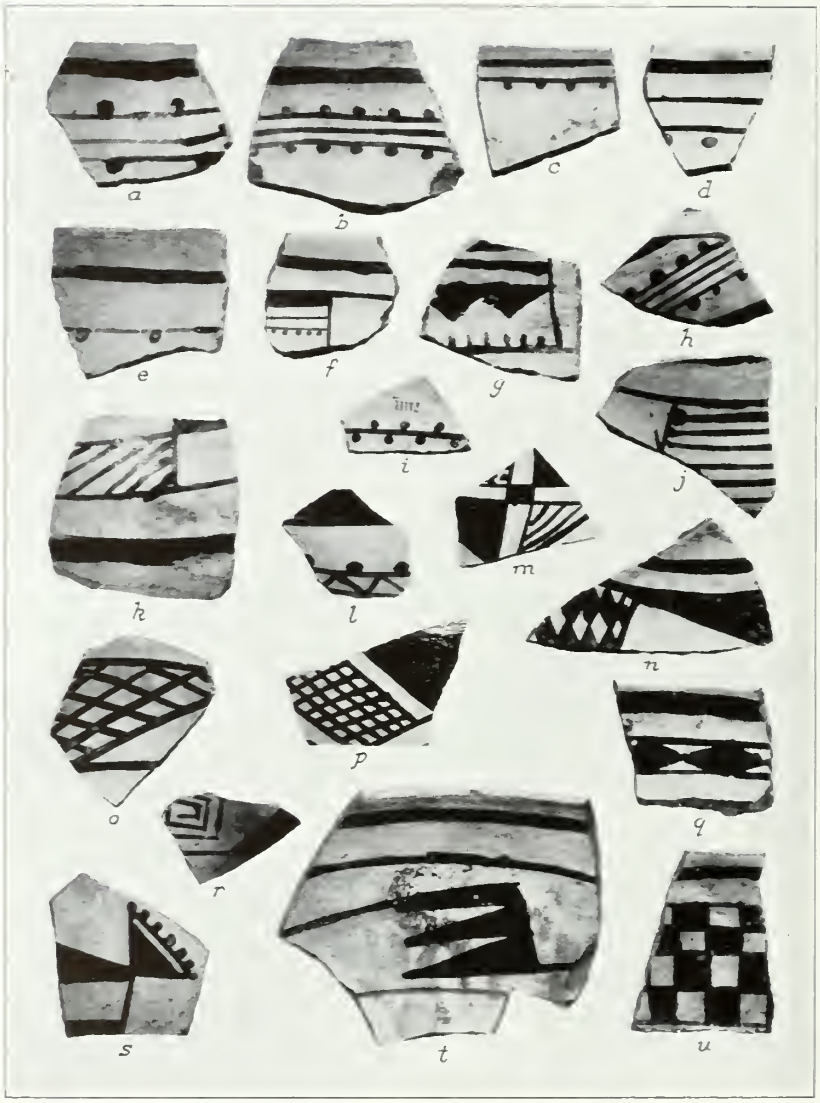


Fig. 55. Glaze I Yellow. Sherds illustrating use of dots and lines. *g*, *h*, *j*, *k*, *l*, *m*, *o*, *p* from ollas, the rest from bowls. (Width of *t* at rim, $3^{3}/_{4}$ inches)

arrangement of the two pendent triangles and the peculiar human head that fills the remaining space. Brushwork is bad, the glaze is thin, brownish, and in places "untaken." Yet, in paste and shape, the bowl is typical of Glaze I Yellow. It may have been the work of a child, although it accompanied the skeleton of a middle-aged woman (Skel. 843).

ELEMENTS OF GLAZE I YELLOW DECORATION

Most of the elements which go to make up Glaze I Yellow designs are so closely similar in nature, treatment, and relative frequency to those of Glaze I Red, that to describe them separately would involve useless repetition of the material presented on pp. 27-38. Lines are identically used, both in the laying off of patterns and in their enrichment. Hatching is again rare, Crosshatching well-nigh absent; the Stepped line is extremely abundant (fig. 52). Dots are perhaps employed a trifle more freely than in Glaze I Red; Checkerboarding, particularly the Dotted checkerboard ribbon (fig. 53, *a-e*), is certainly commoner; it is, indeed, one of the diagnostics of Glaze I Yellow. Key figures, stalked with base (figs. 43, *a-f*; 54, *a*, *c*, *h*), Stalked without base (figs. 43, *h*; 54, *b*), Unstalked right-angled keys (fig. 54, *k*), Unstalked oblique keys (figs. 43, *k*, *l*; 54, *n*), Slung rectangles (figs. 44, *a-d*; 52, *l*), all appear; the Birdlet occurs, but rarely (figs. 43, *i*; 54, *f*).

Fig. 56. Glaze I Yellow. Cribbing, one of the two occurrences in Pecos Glaze of this common Biscuit device (for the other see fig. 42, *i*). (1/2)

Cribbing is the reduction of a rectangular area, or its complete filling, by lines drawn parallel with and close to two of its sides, then parallel to its other two sides within the first pair, and so on. This device is characteristic of Biscuit ware (see Vol. 1, fig. 42); we have but two examples in all the Glaze pottery from Pecos, the sherd shown in figure 56 and a panel (fig. 42, *i*). An analogous treatment appears in a diamond-shaped field (fig. 44, *j*), but the paired lines cross at the ends to produce small, black-filled diamonds.

Birds, as in Glaze I Red, are normally found perched upon the apexes of pendent triangles (fig. 48). They have the same triangular body and crook head, but the inner end of the crook, which, as was stated in discussion of the Glaze I Red birds, may represent the lower mandible, is more regularly carried forward from

the neck (fig. 57). A dot sometimes placed in the crook obviously depicts the eye (fig. 57, *c*, *d*). This device is rare in Glaze I Red. The tail is more often a single elongated projection with interior embellishment, than the series of straight lines usually seen in Glaze I Red birds. The tail in fig. 48, *c* appears to represent an eagle feather,[1] and a long pendent object in fig. 48, *a* has the same peculiarly shaped black end. This leads one to wonder if the Glaze I birds are not all depictions of eagles. The hooked beak would, of course, be in character. It would equally well, however, suit a parrot or macaw, birds held sacred by the Pueblos, ancient and modern. A

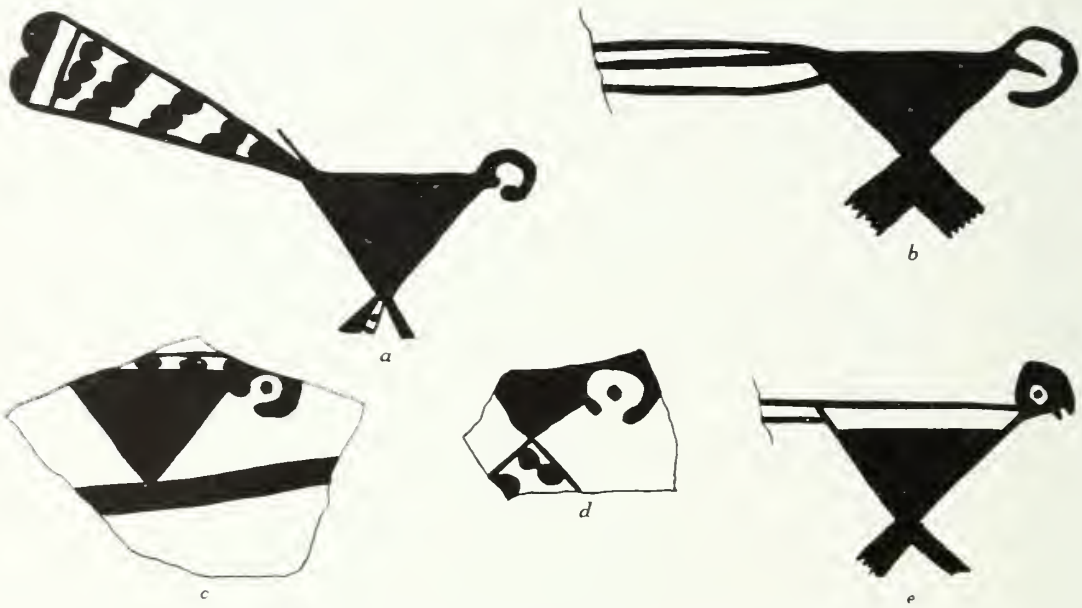


Fig. 57. Glaze I Yellow. Birds. *a*, *b*, *e* from bowl; *c*, *d* from olla sherds. The bird at *c* is unusual in that it is set upon a line rather than, as is conventional, upon the apex of a triangle; that at *e* departs from the normal in the naturalism of the head. (1/2)

distinctly psittacoid look is also given to many of these creatures by the short lower mandible.

Although, as has been said, there is very little difference between the decorative elements of Glaze I Red and Glaze I Yellow, one obtains the impression that the latter is somewhat more elaborate and "finicky" than the former. This feeling, however, may to some extent be due to the fact that the decorations of Yellow stand sharply out against light backgrounds and that details are emphasized which are more or less lost upon the much darker base-color of Red. The foregoing analyses

[1] Chapman, 1927, argues convincingly for this identification of similar figures on other types of pottery. See also feather representations from Biscuit A (Vol. 1, fig. 48), Biscuit B (Vol. 1, fig. 79) and Modern painted (Vol. 1, fig. 96); as well as upon clay pipes (Kidder, 1932, fig. 157).

have certainly proved that the decorative systems of the two types are essentially the same.

BOWL EXTERIOR DECORATION

Few Glaze I Yellow bowls lack exterior decoration. The commonest embellishment is a single pair of oblique dashes (figs. 34, *b'*, *c'*; 35, *b'*); paired vertical dashes are rarer (fig. 46, *a'*); as are X-marks or crosses (fig. 58, *c*, *d*). Very unusual are small unit designs (figs. 35, *a'*; 58, *e*, *f*; 59, *a*, *b*).

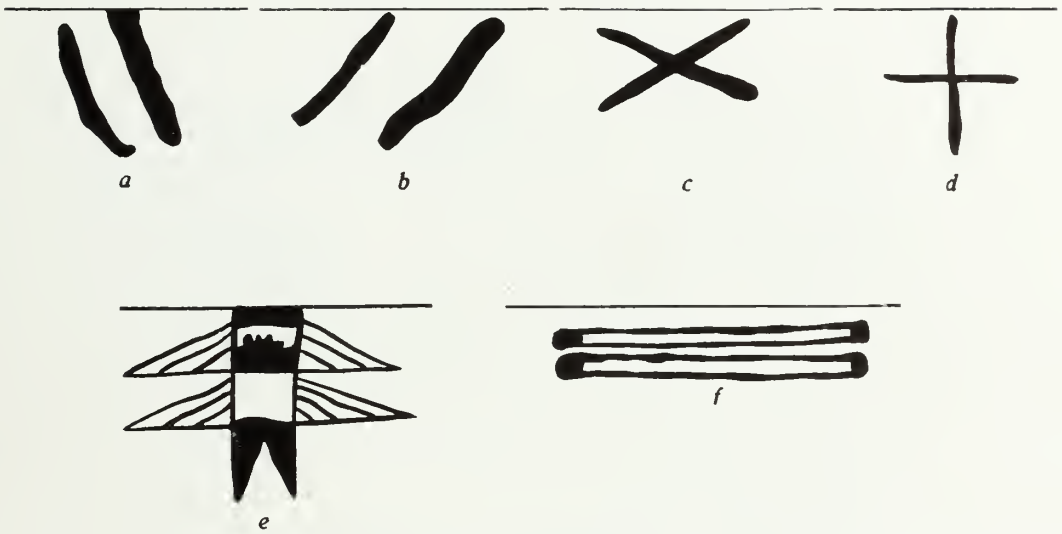


Fig. 58. Glaze I Yellow. Exterior decorations from bowls. The pairs of dashes and the cross and X are characteristic. More elaborate treatments, such as *e*, *f*, are unusual. (1/3)

GLAZE I YELLOW POLYCHROME

Although Glaze I Yellow is normally a two-color type, there are certain vessels which achieve a polychrome effect through use of red slip. The commonest of these are bowls with normal light slip in the interior and red slip on the exterior.[1] There are twenty-six sherds from such pieces. A few ollas have a light body-field, with red-slipped neck and bottom. Whether or not these belong to the San Clemente Glaze-polychrome variety can probably be determined by technological study.

More striking polychromy occurs in a limited number of other pieces (30 bowl, 14 olla sherds—it must be remembered that these were culled from among many thousand ordinary fragments).[2] The patterns contain small red-filled areas (fig. 59,

[1] Comparable to Mera's "San Clemente Glaze-polychrome."
[2] Comparable to Mera's "Cieneguilla Glaze-polychrome."

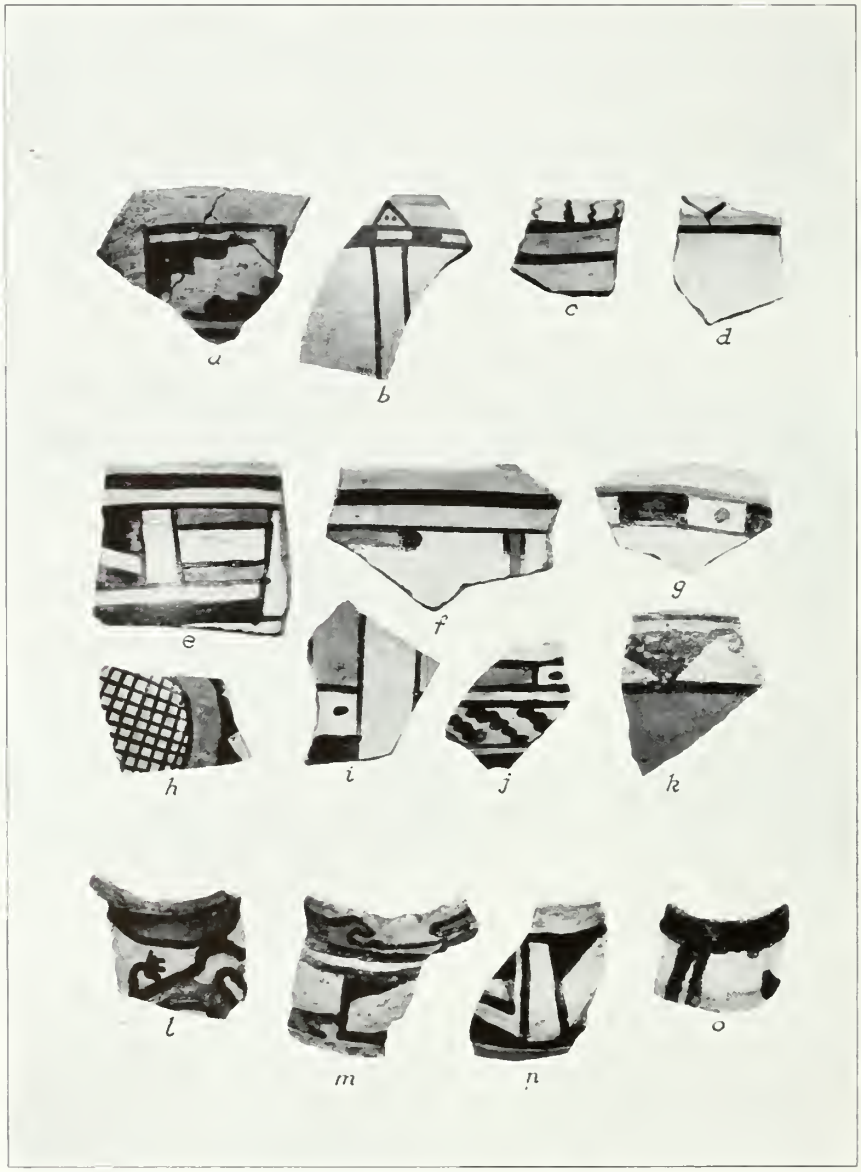


Fig. 59. Glaze I Yellow (*a-k*) and later Glazes (*l-o*). *a*, *b:* Unusually elaborate decorations on bowl exteriors. *c*, *d:* Decoration on interior of recurved rim. *e-k:* Sherds of the rare polychrome subtype, with designs enriched by red paint. *e*, *f*, *i:* Bowl interiors. *g*, *h:* Ollas. *j*, *k:* Bowl exteriors. Red edging (upper line of *g*) is exceptional. *l-o:* Fragments of miniature ollas; *l*, *m* probably Glaze III; *n*, Glaze II; *o*, Glaze V. (Width of *e* at rim, 2½ inches)

e, *f*, *h*-*k*) or, more rarely, red edgings (fig. 59, *g*). In rim shape, design and nature of glaze, the specimens appear to be perfectly normal examples of Glaze I Yellow. They are, however, distinctly yellower than the run of the two-color vessels, and their painting is rather better than usual.

In the case of bowls, the red fills are, with one exception (fig. 59, *k*), in the interior; upon ollas they are confined to the body (fig. 59, *h*). They enliven and enrich the patterns, but they are always of secondary importance, they never constitute a major feature of design, as do the glaze-outlined red keys or birds that adorn the exteriors of bowls and the necks of ollas in Glaze II and later types.

LOCAL GLAZE I RED[1]

This is an extremely bad redware, characterized by poor color, inferior glaze and wretched decoration. The bowls have, for the most part, direct, unmodified rims, but there are a few pieces whose rims are distinctly thickened. In the field such specimens were called Glaze II Red. Further study of the material, however, with re-examination of the stratigraphic evidence, leads me to believe that it was made in small quantities throughout the later part of the Glaze I period, when Glaze I Yellow was in the ascendant; and that it continued to be produced, in perhaps still smaller amounts, well into Glaze II times. The postulated contemporaneity with the later stages of Glaze I Yellow would account for the relatively high percentage of unthickened rims; a survival into Glaze II would explain the presence of a certain number of heavier ones. Only on the hypothesis of a fairly long life as a minor product can I account for the fact that although we have about thirty whole pieces from graves, we never find a respectable representation of sherds in any given cut of the stratigraphic tests. No light is shed on the problem by study of the selected sherds from general digging, the type under consideration being practically absent from that category of material, because, naturally enough, such poorly-marked, inconspicuous, contemptible-looking fragments mostly went into the discard. This is an excellent example of the danger of selective collecting, for were we not in possession of the mortuary bowls and the unculled sherds from the tests we would not be aware that the type had ever existed. From an esthetic point of view, the loss would not be great, the stuff being, as I have said, execrable. Why it should have continued to be made for so long a time is a mystery. It is without doubt a degenerate form of Glaze I Red, the last gasp, so to speak, of the red-slip tradition. It is certainly not early, as its crudity might suggest, because it does not appear at all in the tests until Glaze I Red is definitely on the wane. It reaches maximum representation (although it is never common) in the upper Glaze I cuts that carry a preponderance of Yellow; it falls away in those containing Glaze II. Well before the time that Glaze II had changed into Glaze III it had apparently passed out of existence.[2]

GENERAL CHARACTERISTICS[3]

The ware is two-color: dark glaze on red background. The color of the slip varies greatly; a few specimens are a fine, rich red, but most pieces are a dull, dead brown. The slip, like that of Glaze I Red, is very thin and normally uncrackled; it is soft and subject to wear; usually, but not always, it is very thickly sown with minute particles of mica. Although the surfaces are smoothly and evenly finished, they are less "slick" and less agreeable to the touch than those of Glaze I Red.

[1] A Pecos variant not included in Mera's (1933) classification.

[2] The above was written before Miss Shepard had made her technological studies, which indicate that this ware, which I originally called "Glaze I Red, Degenerate Type," represents the first local attempts to imitate Glaze I Red (see p. 520). The problems involved will be discussed in the conclusion.

[3] For technological description by Miss Shepard, see pp. 502-504.

The paint is black. It is a wretched, lustreless substance, so poorly taken that, were it not for its thickness and an occasional glint of vitrification, one would hesitate to call it a glaze. It often wears or scales off. (fig. 4, *c*).

VESSEL SHAPES

BOWLS

This is the only surely identifiable form. Ollas presumably were made, but I have no evidence to that effect beyond a few poorly decorated red olla sherds from the general digging. Bowls, as in Glaze I Red, are of two sorts, large and small; small bowls, however, are relatively much more common than in Glaze I Red (45% as against 6%).

LARGE BOWLS (fig. 4, *c*, *d*) are of the same general shape as those of Glaze I Red (fig. 1), though they are distinctly less truly and evenly moulded. The *rim* is normally unthickened, the lip rounded or flat with rounded corners (fig. 68, *a-c*): a few sherds have a slightly thickened rim, thus approaching the form most typical of Glaze II (fig. 68, *d-h*). *Size:* diameters are from 11 to 12¾ inches, depths 4½ to 5½ inches. *Orifice-depth index* ranges from .37 to .45, average .41. *Capacity*, 5 to 6 dry quarts (5.5-6.6 litres). *Thickness* of bowl walls, 3/16 to ¼ of an inch.

SMALL BOWLS are better moulded than large ones. The *rim* is unthickened. *Size:* diameters are from 6 to 9 inches, depths 2¾ to 4 inches. *Orifice-depth index* averages .45 (relatively deeper than large bowls). *Thickness* of walls, 3/16 to ¼ of an inch.

GENERAL DECORATIVE FEATURES

COLORS. Black, poorly taken glaze on dark red or brownish background. Two bowls have light exterior slip.

SLIP EXTENT. Entire surface of bowl, within and without. The above-mentioned two bowls with light exterior slip have unslipped, reddish exterior bottoms.

ZONES OF DECORATION. Upper part of interior. Exterior undecorated save for a cross or two pairs of oblique dashes; about half the bowls have no exterior decoration.

BOWL INTERIOR DECORATION

Bands	17
Pendent keys	3
Pendent triangles	2
Lunes	1
All-over patterns	1
	24[1]

[1] The decoration of several bowls was too badly worn even to permit classification; and of the seventeen bowls with band patterns only the ten illustrated in figs. 60 and 61 could be copied with any assurance of accuracy.

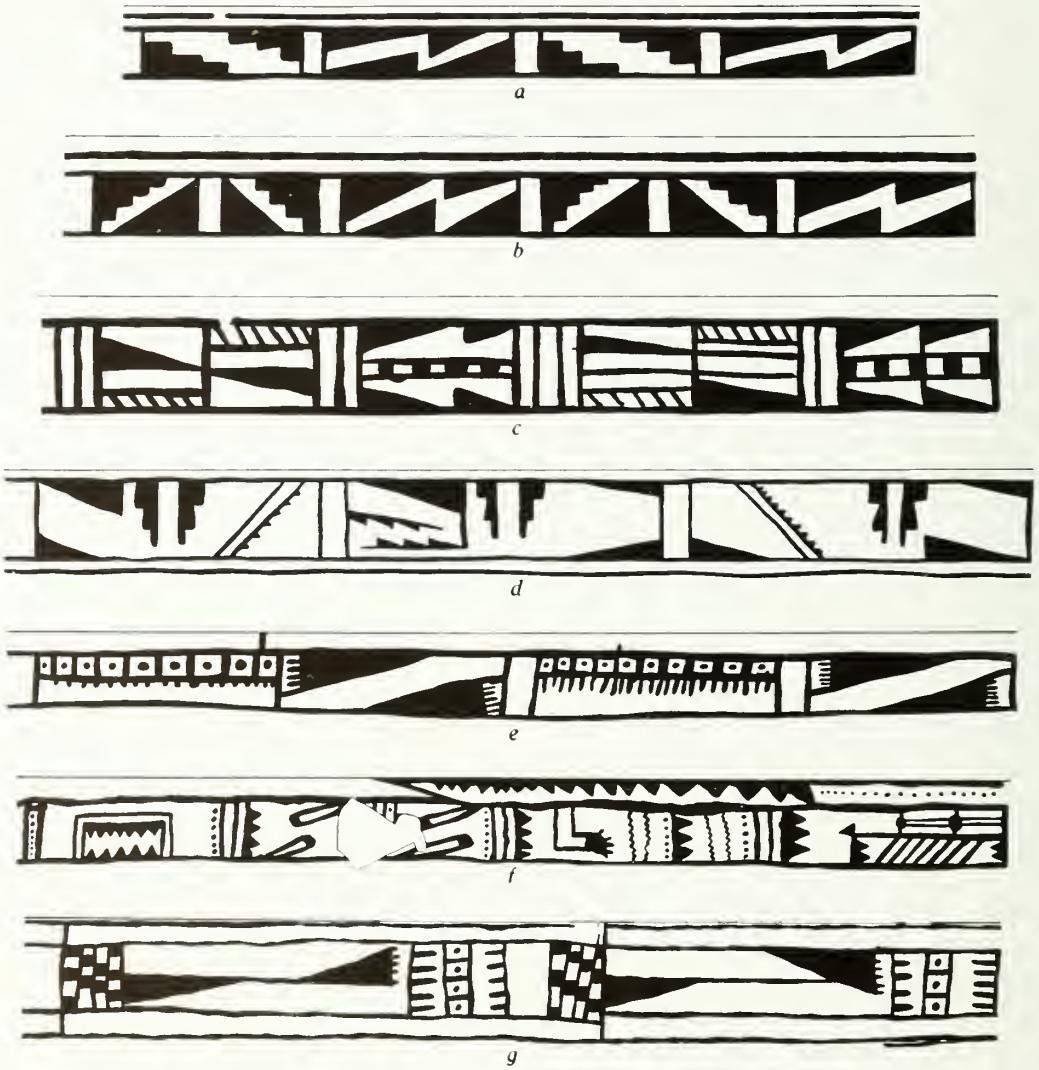


Fig. 60. Local Glaze I Red. Band patterns from bowl interiors. The simplification and coarsening of the designs should be noted, as well as the deterioration of brushwork (cf. figs. 9-11.) (1/8)

BAND PATTERNS

AREA COVERED. Bowl interior from just below lip downward for 1½ to 5 inches, leaving bottom of bowl undecorated. There is, as can be seen from the measurements just quoted, great variability in the width of the bands.

FRAMING. A single, irregularly drawn upper framer, broken or unbroken, was used in about half the bands (fig. 60). It is of approximately the same thickness as the banding lines, which are also poorly executed.

PANELING is the rule, the decorator evidently having striven to adhere to the four-panel, alternating formula of Glaze I Red and Yellow. The panels are separated by a mere open space between the paneling lines and in only one case (fig. 60, *c*) is there a reminiscence of the free-standing paneling bar so common in Glaze I Red.

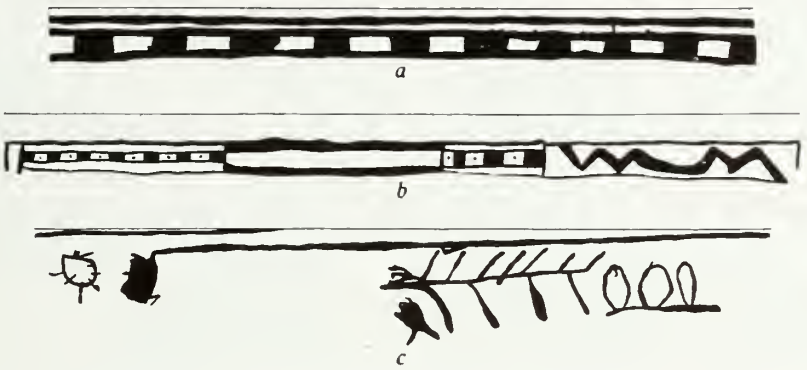


Fig. 61. Local Glaze I Red. Band patterns from small bowls. *a*, *b:* Narrow bands. *c:* Example of extremely slipshod decoration; the sherds indicate that comparably bad painting was not rare in this type. (1/8)

PANEL LAYOUT. The material is so scanty that it has not been thought worth while to attempt a classification of treatments. The bands illustrated in figure 60 indicate that there was a coarsening and simplification of design comparable to that which, as will be described below, took place in light-slipped pottery during the transition from Glaze I Yellow to Glaze II. There should be noted the absence of the paired key figures on stalks which are so common in Glaze I, and the preponderance of panels decorated with large keys (fig. 62, *g*, *h*) and pairs of opposed triangles (*i*, *j*). How bad the decoration of bowls of this type might become may be seen in fig. 61, *c*.

PENDENT KEY PATTERNS

This is a type of pattern not observed in Glaze I Red, but occurring in Glaze II (see p. 97 and fig. 83). It consists of large unstalked key figures, set back-to-back in pairs, which hang from a broken line encircling the bowl just below the rim.

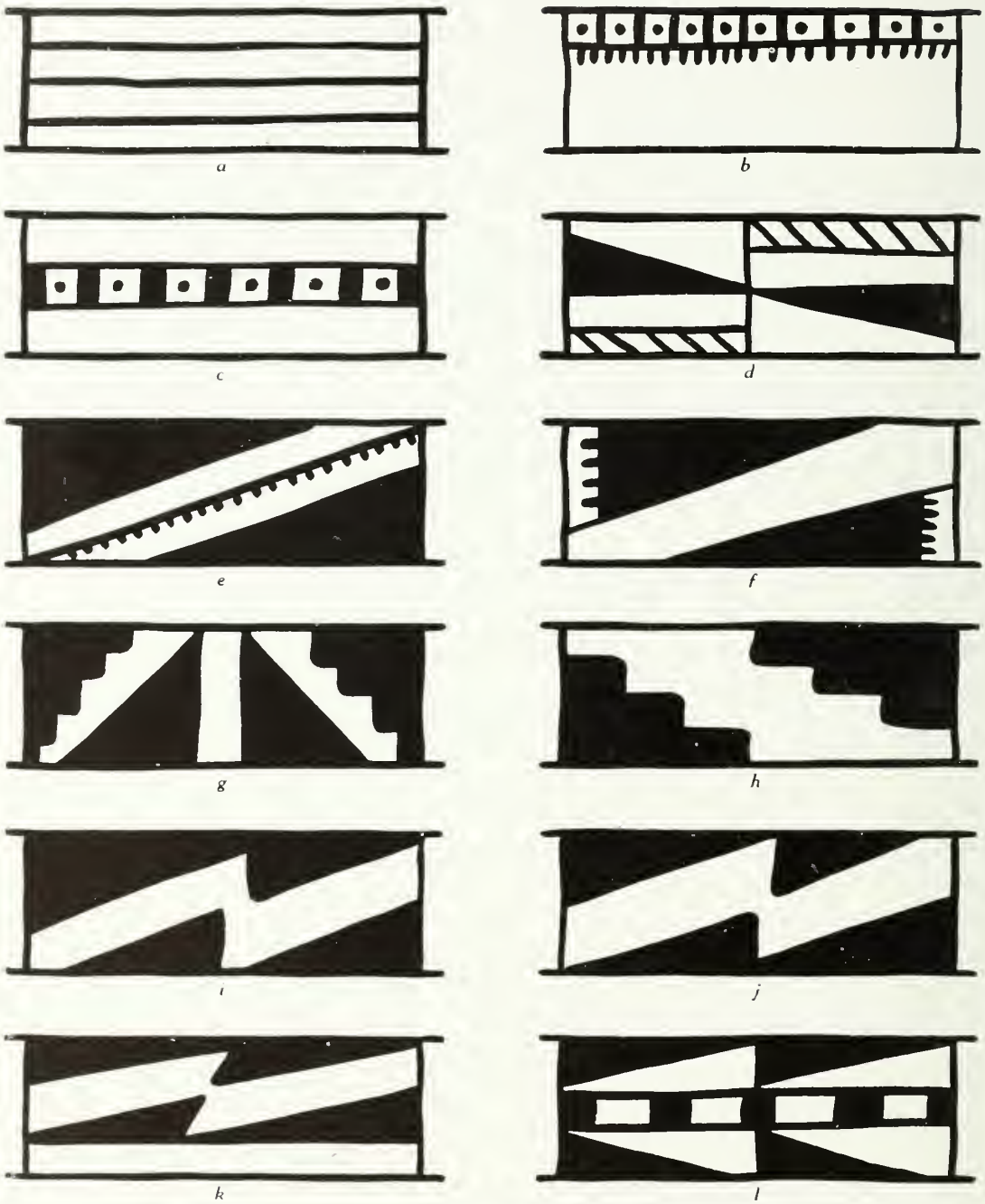


Fig. 62. Local Glaze I Red. Panels from band patterns.

There are three examples among the whole pieces (fig. 63), and such sherds as we have indicate that the device was reasonably common. The paired keys in panels (fig. 60, *d*) illustrate an intrusion of this figure into a band pattern.

PENDENT TRIANGLE PATTERNS

The two sherds illustrated in fig. 64 indicate that this standard Glaze I Red arrangement persisted into the local manifestation of the ware.

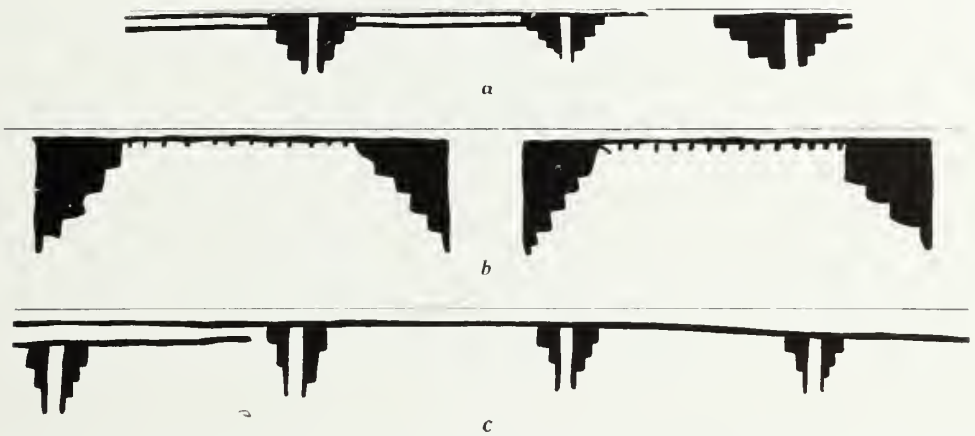


Fig. 63. Local Glaze I Red. Pendent key patterns. This type of decoration is confined, in Pecos Glaze, to Local Glaze 1 Red and to Glaze II. (1/6)

Fig. 64. Local Glaze I Red. Pendent triangle patterns. (1/8)

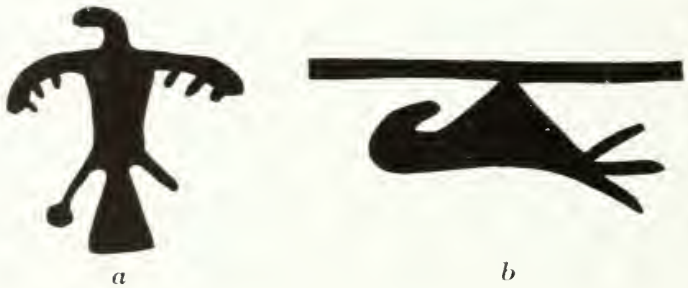
LUNE PATTERN

A single bowl, too badly defaced by the wearing away of its soft slip and the chipping of the dull, untaken glaze to permit copying, was decorated with what appear to be two crudely drawn lunes.

ALL-OVER PATTERN

The bowl illustrated in fig. 65 has a broad band drawn boldly across the interior and two four-appendaged figures in the side spaces. The median band is not seen in Glaze I Red, although it occurs in certain Glaze I Yellow bowls (see fig. 51, *b*, *e*).

Fig. 65. Local Glaze I Red. All-over pattern from bowl interior. (1/5)



a *b*

Fig. 66. Local Glaze I Red. Bird figures from sherds. *a:* Exterior of small bowl. *b:* Pendent from the lower banding line of band pattern. (1/2)

BIRD FIGURES

The two birds reproduced in fig. 66 are the only examples noted in the decoration of Local Glaze I Red.

GLAZE II[1]

The pottery last described was originally called Glaze I Red, Degenerate Type. The present type might equally well be termed a degenerate form of Glaze I Yellow, for that is exactly what it is. I have nevertheless accorded it typical rank under the name of Glaze II, because it does not mark, as does the local red Glaze, the dying out of a technique, but carries forward, albeit badly, the Glaze I Yellow tradition, at the same time beginning to take an certain qualities which are later strengthened to become characteristic of Glaze III.[2]

Like all transitional material, Glaze II is difficult to describe. It lies between two strongly marked types: some pieces resemble Glaze I, others can hardly be distinguished from Glaze III. It may well be that I have erred in assigning certain specimens to this type. Stratigraphic evidence as to Glaze II is most unsatisfactory, for it was relatively so short lived that no test carried a large representation of it, nor were there found any pure deposits dating from the time of its manufacture. The best collections came from below the South House at Pecos, where there were beds entirely free from strongly marked Glaze I, but which contained, in their lower measures, much Glaze II, which changed, toward the surface, to unmistakable Glaze III. Most of the bowls described in the following pages came, however, from graves, and there is no way exactly to date a burial. Hence, as I have just said, some of my identifications may be wrong. But the criteria for making the identifications were established only after very careful study of the sherds and after proving, to my own satisfaction at least, that certain technological and artistic trends were operative during the general period under discussion.

There is practically no literature regarding the pottery which, at Pecos, I call Glaze II. Glaze ware from a small ruin on the south rim of the Rito de los Frijoles was described by me in 1915 under the name "Frijolito".[3] It has many resemblances to Pecos Glaze II, but averages much finer. Its probable chronological and genetic relationships to the local product will be discussed in a later section (p. 609). In Nelson's paper on Tano pottery, Glaze II is not specifically mentioned. Two-color pieces were included in his Type II (see fourth bowl rim from left, fig. 21, Nelson, 1916); those with red ornament were assigned to his Type III. Not until 1917, when the Pecos test material from the 1915 and 1916 excavations had been studied in the laboratory, was Glaze II given typical rank.[4]

[1] Comparable material constitutes Mera's Group B, made up of "Largo-Glaze-on-yellow" and "Largo Glaze-polychrome".

[2] The above was written before Miss Shepard's technological studies had been made. It now seems probable that neither Glaze I Red or Glaze I Yellow was made at Pecos. If this proves to have been the case, Glaze II, which is surely of local manufacture, may owe its crudity to the fact that it was (with Local Glaze I Red) produced by inexperienced potters. Be that as it may, and regardless of its exact ancestry, Glaze II is transitional, in decoration, between Glaze I Yellow and Glaze III.

[3] Kidder, 1915.

[4] Kidder, M.A. and A.V., 1917. Collections from the Frijolito ruin are in the Museum of New Mexico and the Peabody Museum; Nelson's Tano material is in the American Museum of Natural History; there are a few pieces from ruins on Santa Fe Creek at the University of Colorado; the Pecos specimens are at Andover and the Museum of New Mexico; in the survey collection of the Laboratory of Anthropology at Santa Fe are sherds from many sites.

GENERAL CHARACTERISTICS[1]

Three-color as well as two-color pieces occur.[2] In both varieties the decoration of bowl interiors and the bodies of ollas is executed in dark glaze on a light background. Three-color specimens are further embellished by glaze-bordered figures in matte red, which are applied to the exteriors of bowls (figs. 69, *d*; 70, *a*, *b*) and to the necks of ollas (fig. 72, *c-f*). The slips which serve as backgrounds for the above decorations can hardly be described more precisely than as "light," for the variety of color is endless. About all one can say is that they are never really white, or truly yellow, or positively gray; dirty yellowish, grayish, pinkish buff perhaps best expresses the general range.

The slip which produces these subtly variable colors is equally variable in quality and in thickness. In some cases, though rarely, it is a heavy coat which completely masks the underlying clay. More commonly it is so thin as imperfectly to cover the reddish paste (fig. 69, *d*); to this is due the pinkish tone of many specimens. Even more commonly the slip has been of such a nature as almost completely to have disappeared, particularly from the interiors of bowls; on the exteriors it usually lasts better, but bare patches of exposed paste often give the vessels a blotchy, moth-eaten appearance. In thickness these impermanent slips seem to have ranged from the thinnest sorts of wash to relatively heavy coats. Crackling, of even the thicker slips, is extremely rare. Surface finish is indifferent. Not more than a handful of sherds and only one bowl can compare in smoothness with the run of Glaze I.

Fire-clouds seem to be less common than in Glaze I Yellow, although it may be that they are merely less evident. On bowls they occur, as before, only on the exterior. Some bowls, again as in Glaze I Yellow, have uniformly darkened interiors, the result of imperfect ventilation while being fired.

The glaze is, on the average, very poor. It is better than the wretched glaze of the Local Glaze I Red, but it is often entirely untaken. It is thicker than that of Glaze I, and where well taken is lustrous black with bluish irridescent lights. Brushed out thin it appears brown or even yellowish. Only very rarely has it run or spread from the lines of its original application. The red of bowl exterior and olla neck designs is, at its unusual best, a handsome pigment. It wears rather better than the slip, but from vessels with impermanent slip it has often disappeared almost completely.

VESSEL SHAPES

Bowls and ollas are the only certainly identified forms, although it is possible that some small, oddly-shaped pieces began to be made during the Glaze II period.[3]

[1] For Miss Shepard's technological description, see pp. 504-506.

[2] Two-color specimens with rims similar to those of Pecos Glaze II are called by Mera "Largo Glaze-on-Yellow"; three-color specimens "Largo Glaze-polychrome."

[3] See section on unusual forms in Glaze, pp. 266 to 272.

BOWLS

As in Glaze I, there are two sorts of bowls, the large and the small. Small bowls, however, are relatively much more common than in Glaze I and pieces of intermediate size, which are absent from the latter group, now begin to appear.

Large bowls (figs. 67, *a*, *c*; 69; 70, *a*, *b*) are evenly curved from rim to rim, with no flattening at the bottom. They are not well moulded, often being imperfectly circular, sometimes slightly lop-sided in profile; the rim tends to waver, both laterally and in height. The point of greatest diameter is at, or slightly below, the lip. The *rim* varies considerably. Plain rims (fig. 68, *a-c*) are not distinguishable,

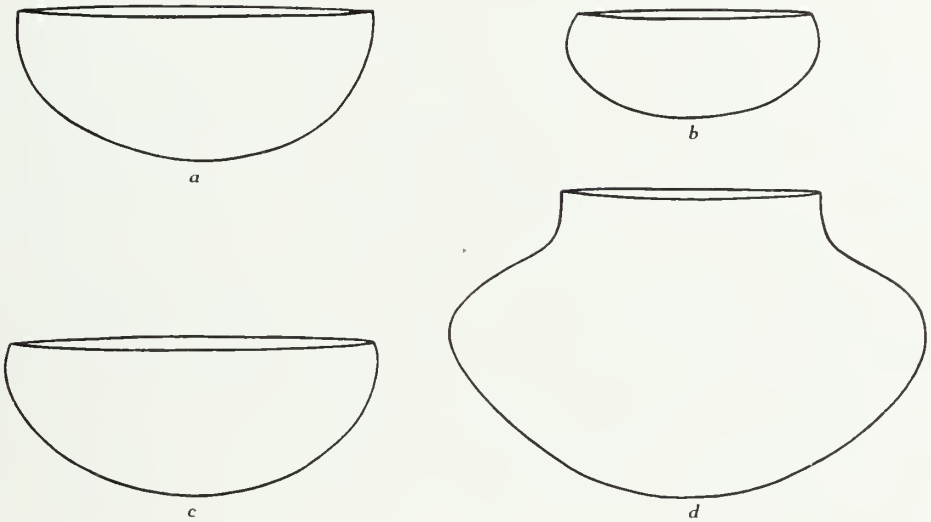


Fig. 67. Glaze II. Vessel shapes. *a-c:* Bowls. *d:* Olla. (1/6)

save by the greater average thickness of the vessel wall, from those of Glaze I. The most characteristic rim is more or less thickened (*d-j*). The thickening is always on the inside, hence the exterior of the bowl has a more gentle curve than does the interior. The thickening is also always greatest at the lip. The *lip* is flat with slightly rounded corners. It is normally horizontal (*d-f*), less commonly inclined inward (*h-j*). Still rarer are examples, which on other criteria seem assignable to Glaze II, with an inside thickening and very slight exterior recurve (*k*); this variety approaches the typical Glaze III rim, and is probably late.[1] *Size:* the range in diameter

[1] The classification of Pecos Glazes, being based on the sum of the characteristics of the pottery, differs from that of Mera (1933), in which rim-form is the sole criterion. The Pecos Glaze II specimens with unthickened rim (fig. 68, *a-c*) would be placed by Mera in his Group A; those with thickened, horizontally lipped rim (*d-g*) in his Group B; those with inward slanting lip (*j*) and with slight outcurve (*k*) in his Group C.

of the thirty-odd measurable bowls is from 10½ to 12¼ inches; the average 11¼ inches. Depths run from 4⅜ to 5½ inches. *Orifice-depth indices* are from .36 to .46; average slightly over .40. *Capacities* average close to 5½ dry quarts (6 litres). *Thickness* of bowl walls is much more variable than in Glaze I. We have pieces from $^{5}/_{32}$ to $^{11}/_{32}$ of an inch thick; the average is $^{7}/_{32}$.

Small bowls (fig. 67, *b*) are rather better moulded than large ones. Their *rims* are usually slightly thickened. *Size:* diameters (12 specimens), 6½ to 9¼ inches; depths, 3¼ to 4 inches. *Orifice-depth indices*, .38 to .51; average .43. The small

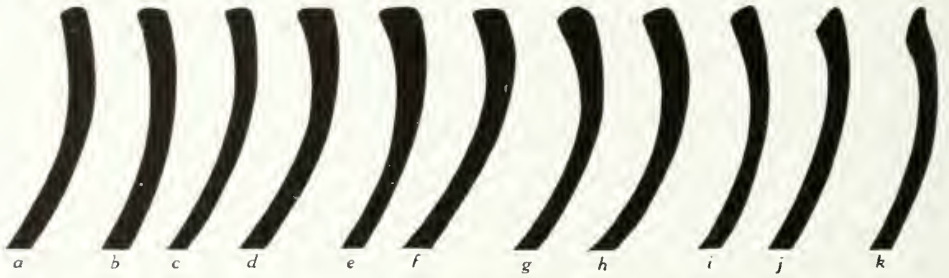


Fig. 68. Glaze II. Bowl rim profiles. Unthickened rims, such as *a* and *b*, are uncommon. Thickened rims, flat-lipped (*c-f*), or rounded (*g-i*), are most abundant. Thickened rims with inward-slanting lip (*j*) are rare, as are those with interior bulge and slightly recurved exterior (*k*). (1/2)

bowls are therefore relatively deeper than the large ones. *Capacities* are from 1¼ to 2½ dry quarts (1.1. to 2.8 litres).

OLLAS

The Glaze II olla is apparently similar in shape to that of Glaze I. Study of our limited material indicates, however, that the body is somewhat less full, the shoulder being more angular, the bottom slightly flatter (figs. 67, *d*; 71). The olla in fig. 6, *b* is probably not of local manufacture; like those from Los Aguajes, La Bajada, and Cieneguilla, illustrated for comparative purposes in fig. 72, *c-f*, it has a slight outcurve at the orifice. This seems to be rare or absent at Pecos prior to Glaze III. The neck rises more nearly vertically than that of any other Glaze olla; the angle between neck and upper body is therefore sharply marked; the *rim* is "direct," sometimes slightly thickened at the lip (fig. 73). The lip is either flat or with the outer corner a little rounded. Approximate *measurements* of very fragmentary specimens: No. 1—fig. 71, *b*—orifice, 9 inches; diameter at shoulder, 17; height, 11¼. No. 2—fig. 71, *a*—orifice, 6½ inches; diameter at shoulder, 15¾, height, 10½. *Capacities* could not be obtained.

Fig. 69. Glaze II. Bowls with band patterns. Note thin, smeared slip of *a* and *d*. (Diam. of *c*, 11½ inches)

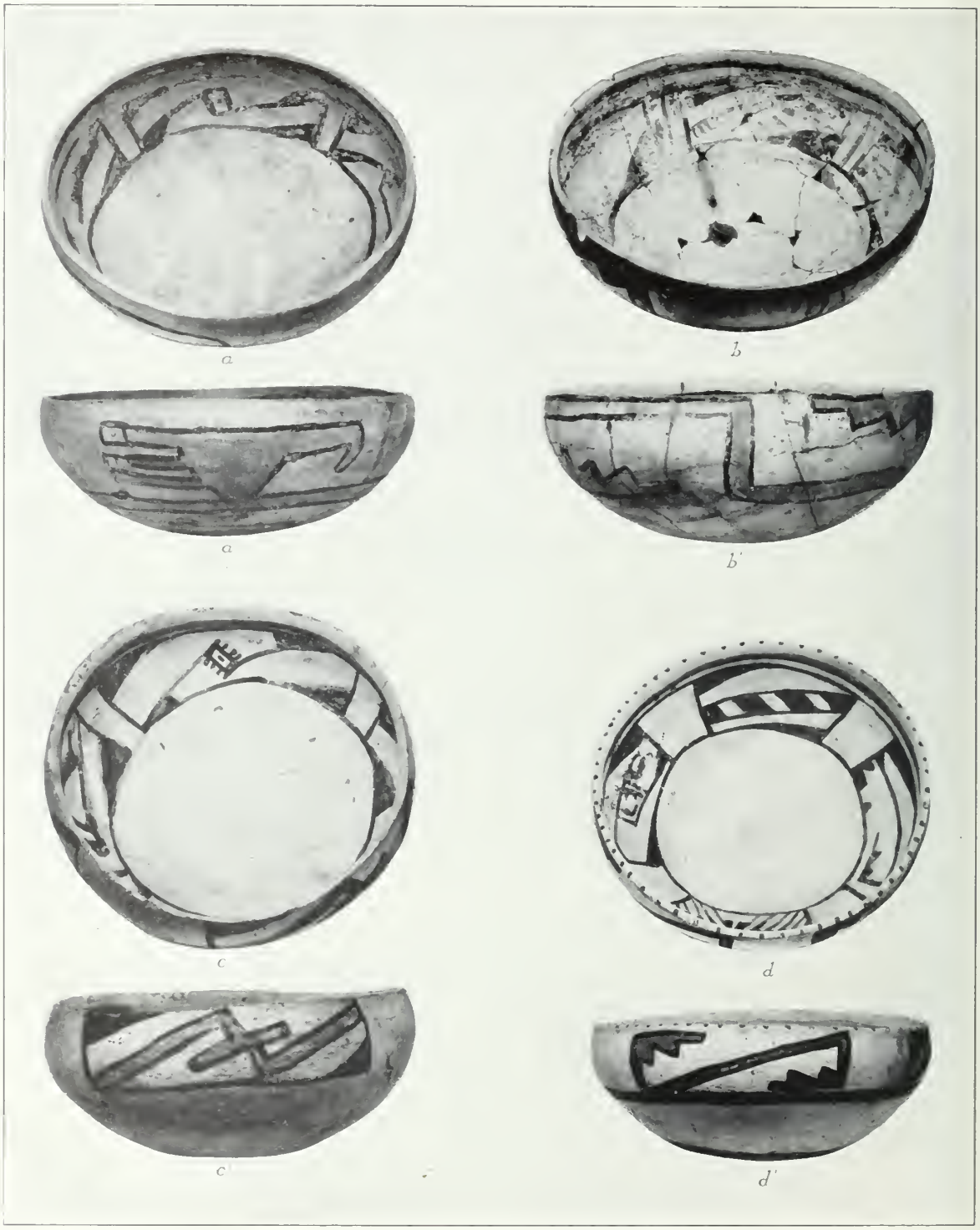


Fig. 70. Glazes II (*a*, *b*) and III (*c*, *d*). Bowls with band patterns. Note improvement in decoration of Glaze III bowls. (Diam. of *b*, 12½ inches)

GENERAL DECORATIVE FEATURES

COLORS. Dark glaze on light backgrounds, exterior decoration of some bowls and neck decoration of some ollas in matte red pigment outlined by glaze.

SLIP EXTENT. *Bowls:* light slip over whole interior and upper part of exterior. A circular area of varying size on the exterior bottom is always unslipped (i.e., left in the red or reddish paste—fig. 69, *a'*, *c'*). *Ollas:* light slip, in some cases at least, covers whole exterior, including bottom. It is probable, however, that the bottom

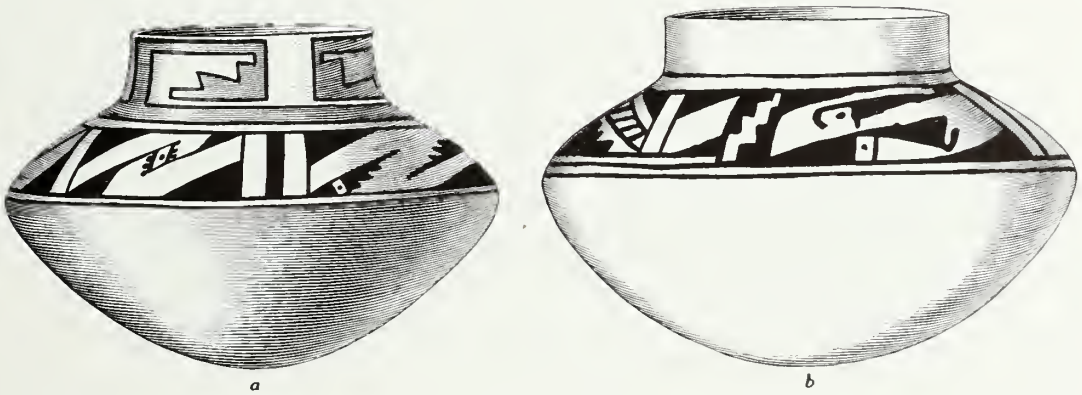


Fig. 71. Glaze II. Ollas restored from sherds. *a:* Late type (decorated neck); pinkish-white slip upon upper body and neck, red slip on bottom and interior of neck. The reconstruction from shoulder to rim is correct, that of the base is hypothetical. *b:* Early type (undecorated neck); yellowish-white slip covers entire exterior. The original specimen is very fragmentary, but enough pieces were recovered to permit accurate reconstruction of shape and of the part of the decoration here shown. (1/6)

was sometimes unslipped. The slip is also applied to the lip and the inner part of the neck; interior of the body unslipped.

ZONES OF DECORATION. *Bowls:* normally the upper part of the interior, very rarely the whole interior; exterior most commonly (about 60%) ornamented with dashes (fig. 69, *a'-c'*) or other simple figures in glaze placed close below lip; but often (about 40%) with red figures outlined with glaze, which occupy the upper part of the vessel-wall (figs. 69, *d'*; 70, *a'*, *b'*). Undecorated exteriors are very rare. *Ollas:* the upper part of the body, from just above the point of greatest diameter to the spring of the neck. The neck is often undecorated (fig. 71, *b*—rarely there are oblique dashes, like those on the exteriors of bowls); the necks of perhaps 30-40% of the ollas bear red decorations outlined in glaze (fig. 71, *a*).

Fig. 72. Glaze ollas from sites other than Pecos. *a*, *b:* Glaze I Red (Agua Fria Glaze-on-red) ollas from Los Aguajes. *c-f:* Glaze II-III (Largo Glaze-polychrome or Espinoso Glaze-polychrome) ollas from La Bajada (*c*, *e*), Cieneguilla (*d*), and Los Aguajes (*f*). Reproduced by courtesy of E. H. Morris and the Museum of the University of Colorado. (Height of *a*, 10¾ inches)

BOWL INTERIOR DECORATION

The almost exclusive predominance of the band in Glaze II decoration is made clear by the following tabulated classification of the patterns from our whole bowls:

Bands	35
Pendent keys	6
Pendent triangles	2
All-over patterns	1
	44

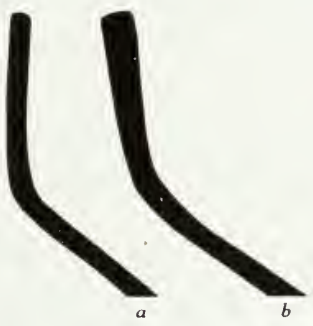


Fig. 73. Glaze II. Olla rim profiles. The data are scanty, but the very straight-sided, almost vertically rising, neck and squarish lip seem characteristic, particularly of early pieces. (1/2)

BAND PATTERNS

Area covered. Upper part of vessel wall from just below lip downward for 3 to 4½ inches.

Framing. A single upper framer habitually, but not invariably, broken by an exit space, is placed about midway between the lip and the upper banding line. The framer, unlike that of Glaze I, is usually little or no heavier than the banding lines. An exit sapce in the upper banding line occurs twice (fig. 74, *f*, *g*); in both upper and lower banding lines once (*a*).

Paneling. There are a few unpaneled bands, for example figs. 74, *g*; 76, *a*, *f*; but the normal arrangement is a division into four panels, separated from each other by rather broad open spaces between engaged paneling lines (see figs. 74, 75, 76). The heavy unengaged paneling bar, abundant in Glaze I Red, and less so in Glaze I Yellow, has disappeared; the only vestige of it that can be noted is in the thin, unengaged line between the panels of fig. 76, *e*.[1] The number of panels is normally four, two unlike pairs in alternating (A,B,A,B) arrangement. A highly

[1] A paneling bar occurs, however, in the probably Glaze II olla shown in fig. 71, *a*.

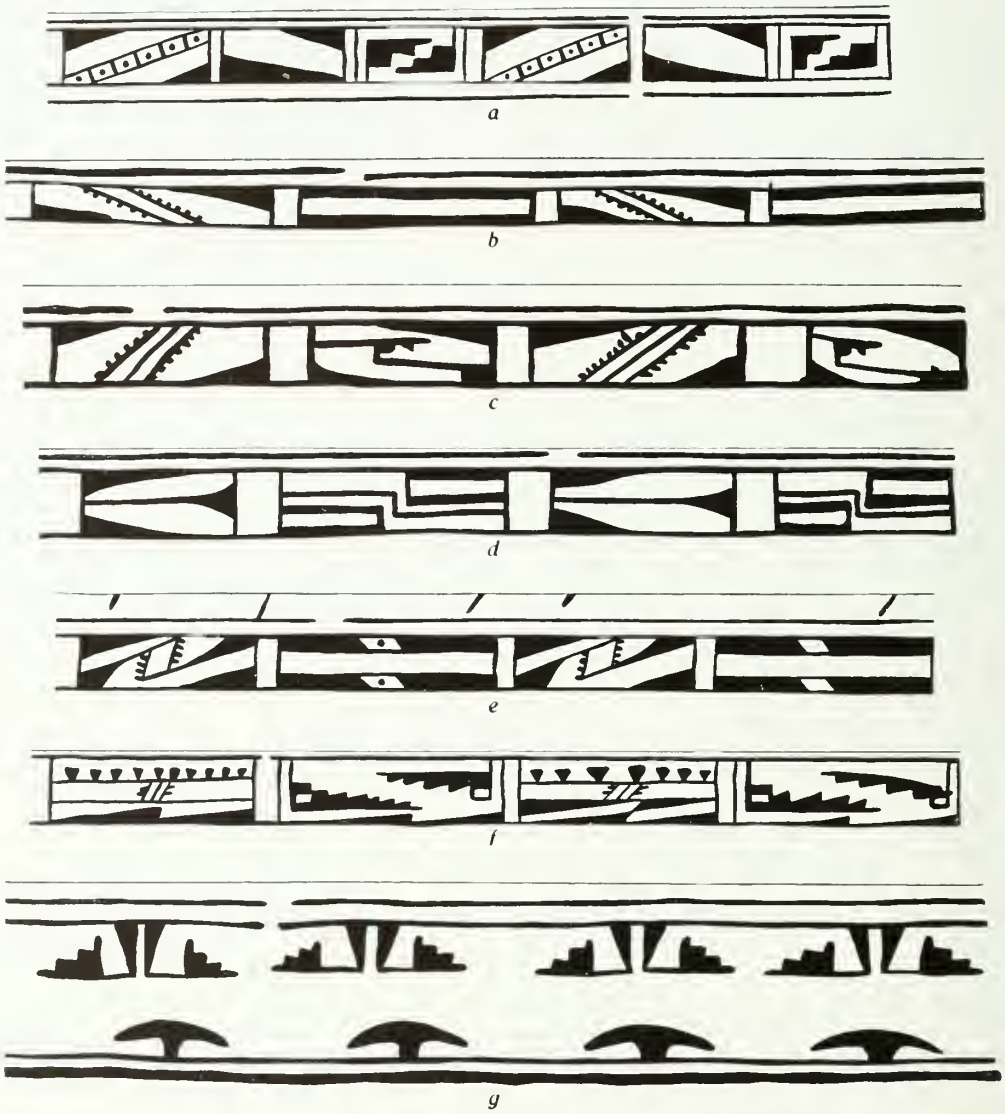


Fig. 74. Glaze II. Band patterns from bowls interiors. The pattern at *g* is unusual in that it is not paneled. The exteriors of these bowls are either undecorated or bear simple dash or cross ornaments. (1/8)

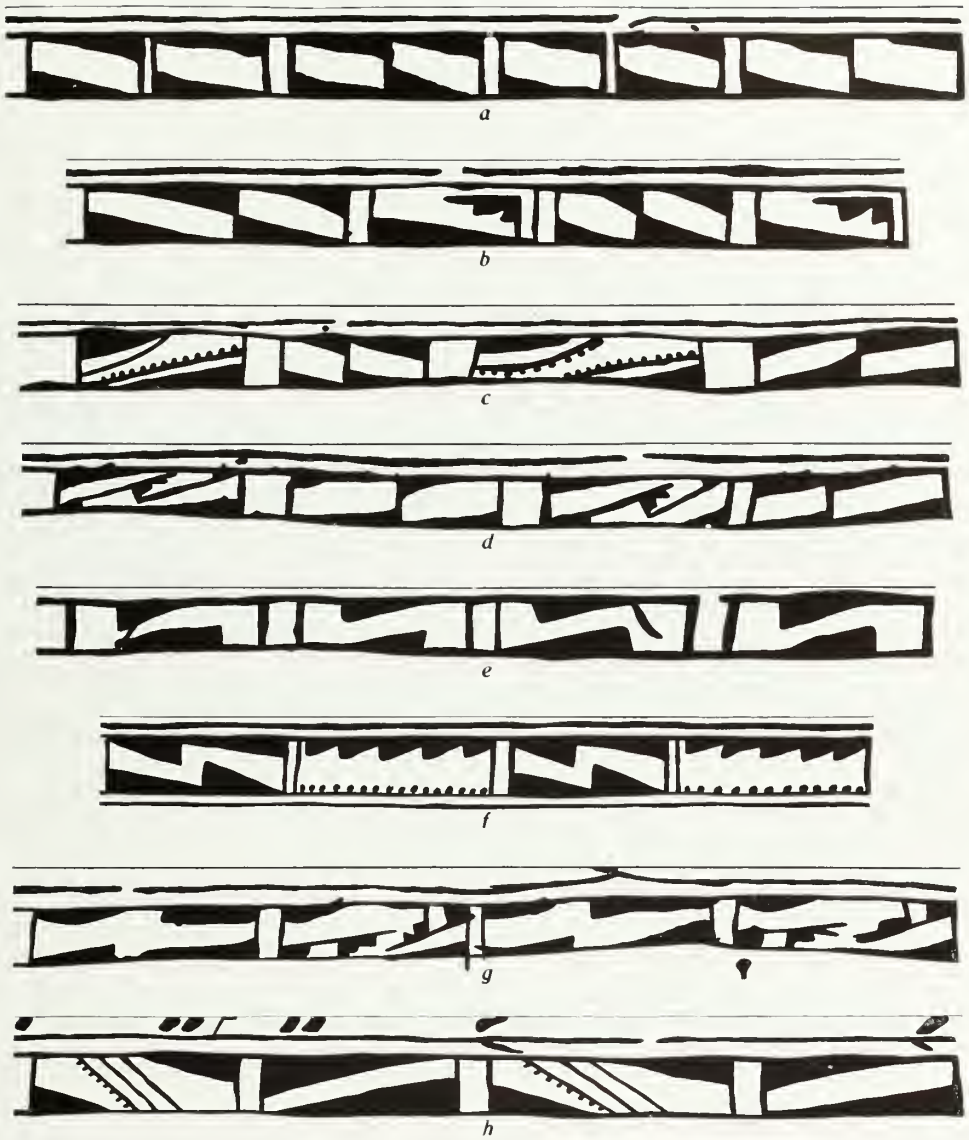


Fig. 75. Glaze II. Band patterns from bowl interiors. Exteriors undecorated or with dash or cross ornaments. (1/8)

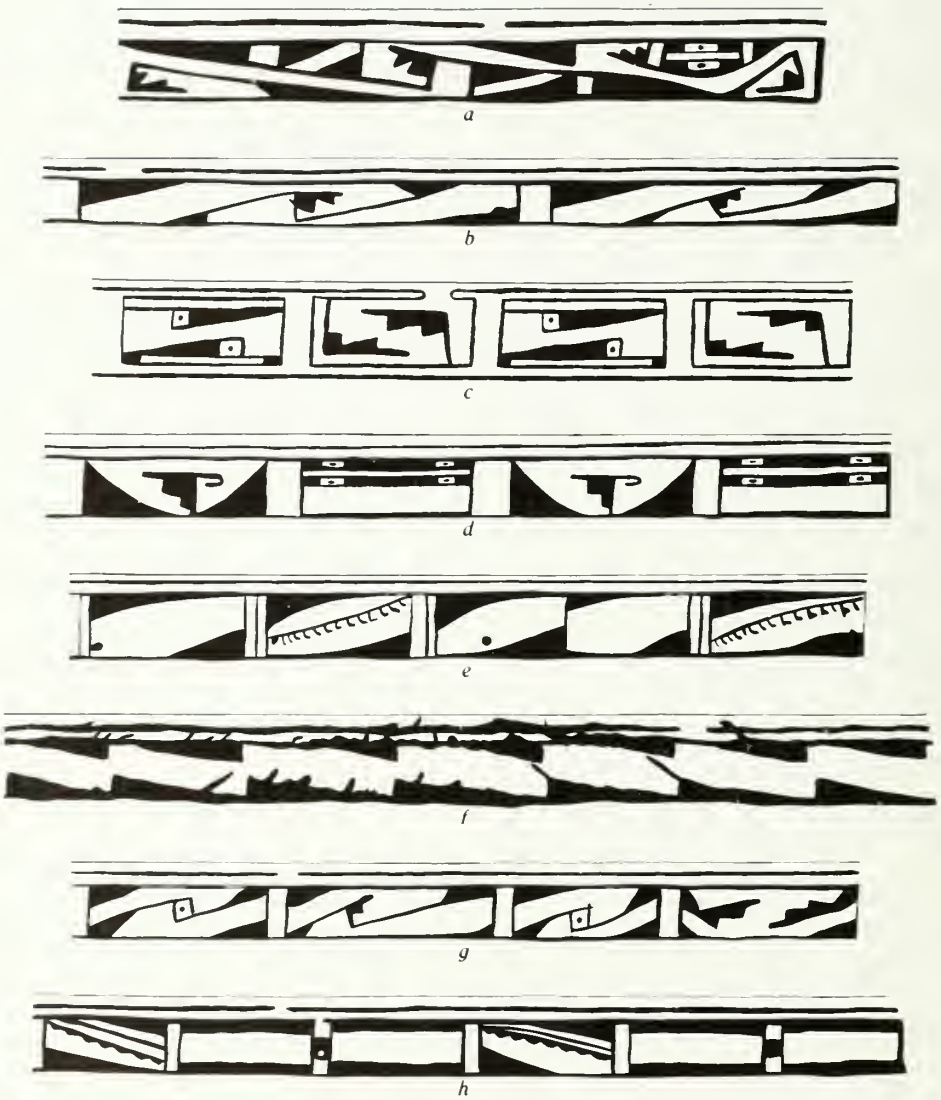


Fig. 76. Glaze II. Band patterns from bowl interiors. Exteriors bear glaze-bordered decorations in red; for that of *a*, see fig. 88, *e*; of *b*, fig. 88, *d*; of *c*, fig. 88, *a*; of *d*, fig. 89, *c*; of *e*, fig. 88, *c*; of *f*, fig. 90, *f*; of *g*, fig. 90, *e*; of *h*, fig. 90, *a*. (1/8)

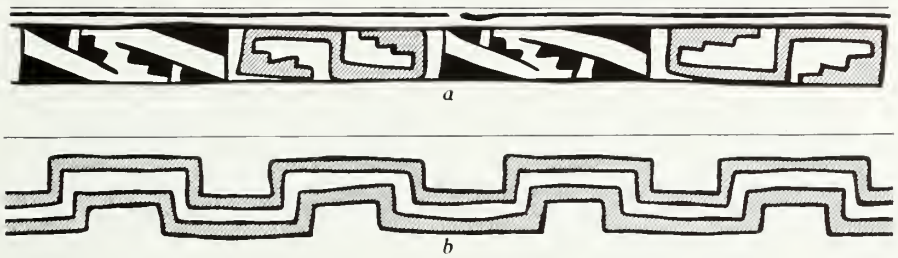


Fig. 77. Glaze II. Interior (*a*) and exterior (*b*) of a bowl which violates all canons of Pecos decorative art by employing double-ended red keys, only properly used on bowl exteriors and olla necks, as part of an interior band. The rim of this bowl is of normal thickened type (cf. fig. 68, *d*). (1/8)

aberrant band from a thick-rimmed bowl (fig. 77) has two normal panels alternating with two red double-ended key figures of the sort properly belonging on bowl exteriors (cf. fig. 88, *a-c*). The presence of these devices on the interior of a bowl must have seemed a horrible decorative solecism to the native potter; for, although the effect is striking, even I, from my long familiarity with Pecos pottery, found myself feeling, at its discovery, that it was somehow not "right."

Panel layout. Glaze II panels were treated as a whole; that is to say, they were never subjected to a preliminary reduction in area by means of a horizontal

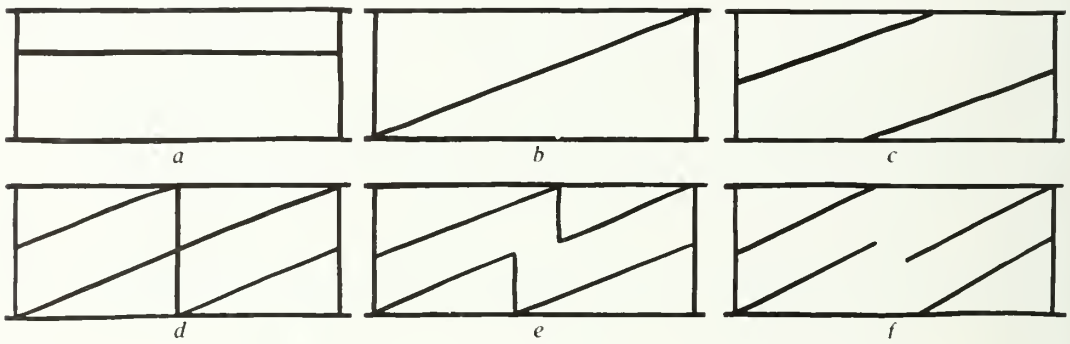


Fig. 78. Glaze II. Methods of panel subdivision. *a:* Horizontal line. *b:* Oblique line. *c:* Corner lines. *d:* Vertical-oblique cross. *e:* Pairs of opposed triangles. *f:* Stalks for opposed elements. (Diagram)

line near the upper or the lower margin of the panel, as was done so often in Glaze I. Decoration was usually planned upon one of the following frameworks:

Horizontal line (fig. 78, *a*)
Oblique line (fig. 78, *b*)
Corner lines (fig. 78, *c*)
Vertical-oblique cross (fig. 78, *d*)
Double opposed triangles (fig. 78, *e*)
Stalks for opposed elements (fig. 78, *f*)

Horizontal line (figs. 78, *a*; 79, *a*, *b*). This is a fairly common arrangement. Lines are drawn parallel and close to the upper margin of the panel (fig. 79, *a*), or close to both upper and lower margins (*b*). The resulting attenuated fields may be left open (*b*), solidly blacked (fig. 74, *b*, second and fourth panels), or blacked save for dotted reserved rectangles (fig. 79, *a*). Other decorations in the horizontal manner are seen in *c*, *d*, and *e*. Each of these occurs but once. That in *c* appears to be an attempt to produce the double cross decoration so often seen in Glaze I (cf. figs. 14, *a-f*; 41, *a-d*).

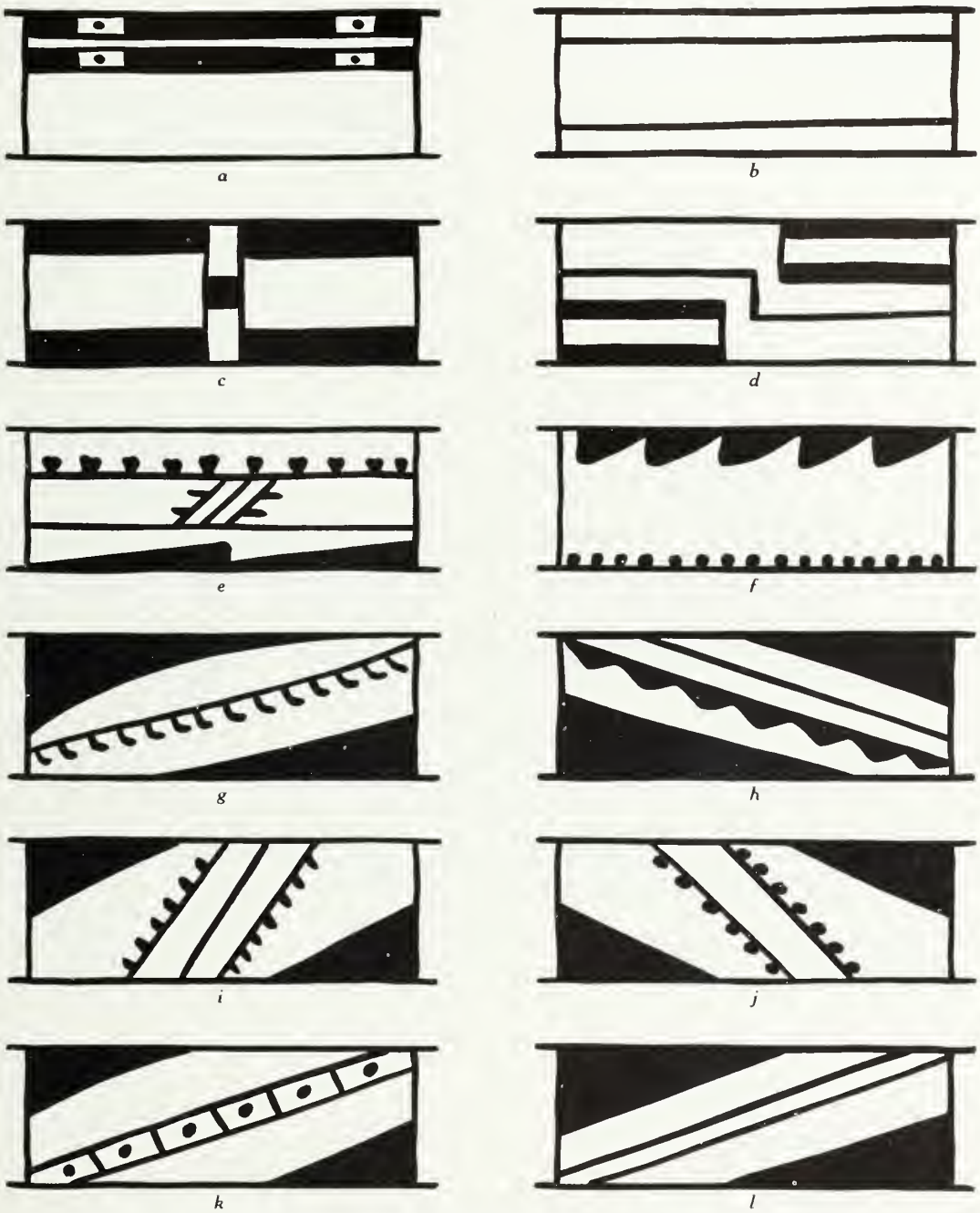


Fig. 79. Glaze II. Panels subdivided by horizontal lines (*a*, *b*); horizontally planned panels (*c-f*); panels subdivided by oblique lines (*g-l*).

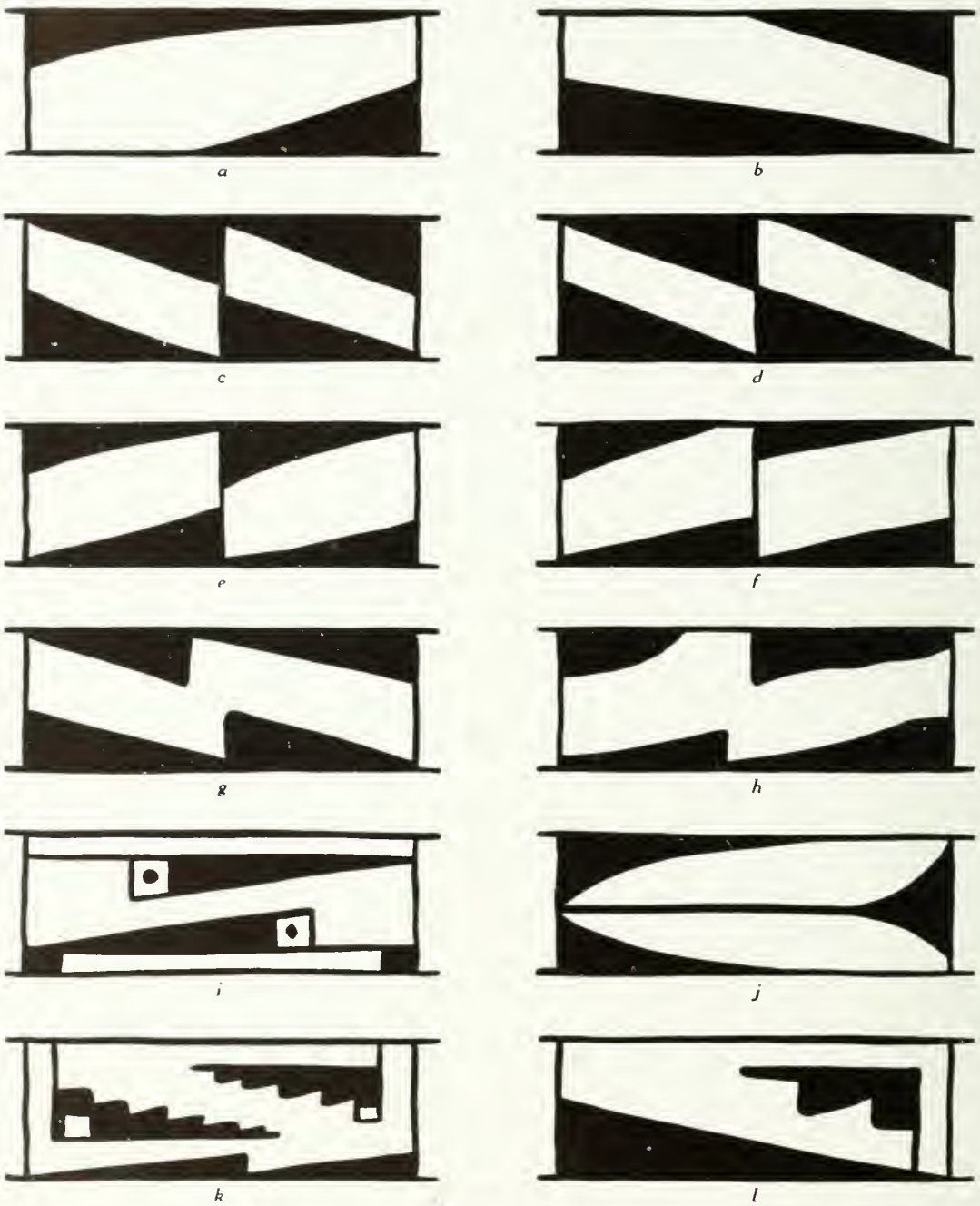


Fig. 80. Glaze II. Panels with corners filled (*a*, *b*); subdivided by vertical-oblique cross (*c-f*); with pairs of opposed triangles (*g*, *h*); unusual panels (*i-l*).

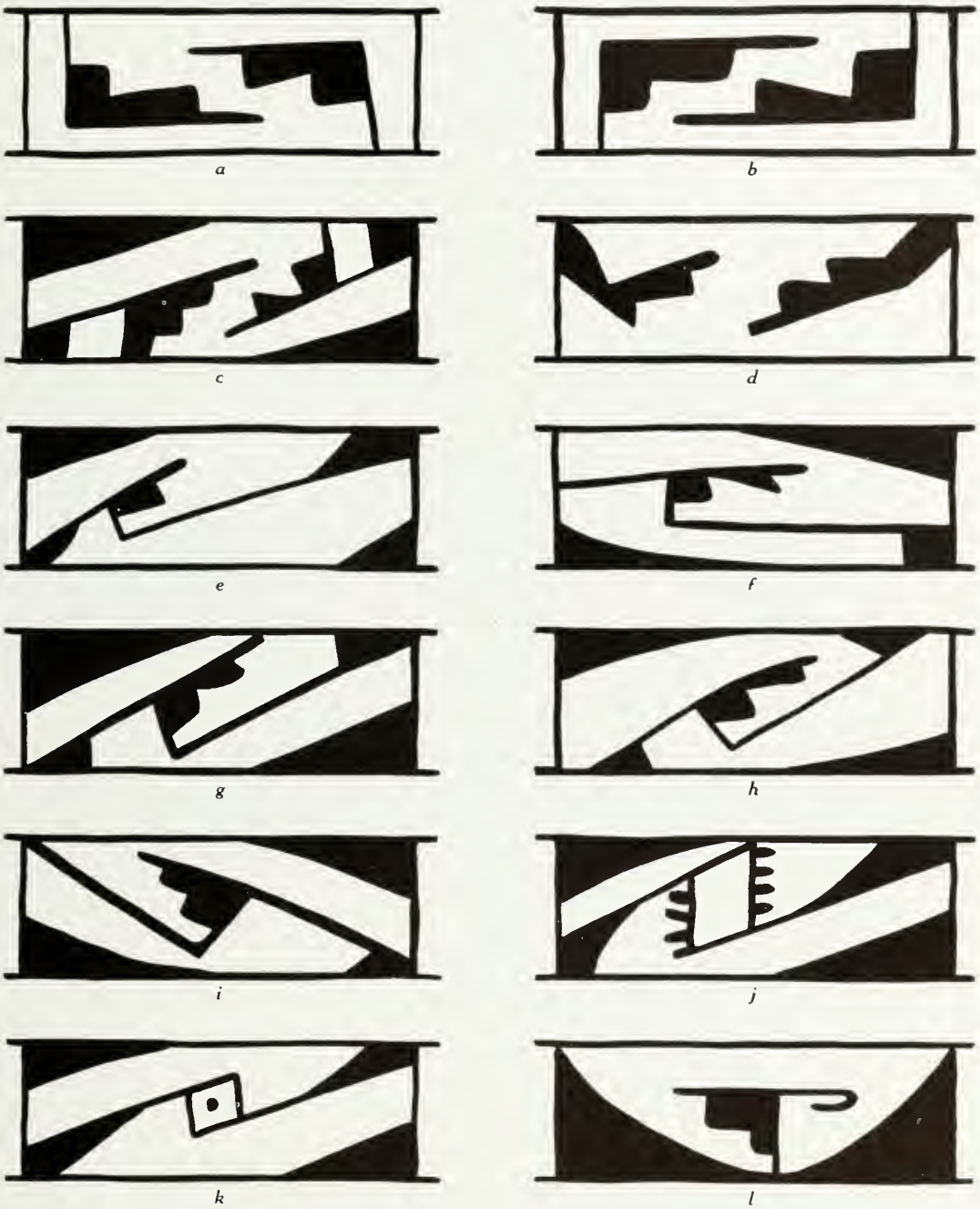


Fig. 81. Glaze II. Panels with opposed keys rising from banding lines (*a*, *b*); with opposed keys emanating from corners (*c*, *d*); with slung key (*e-i*); with slung rectangle (*j*, *k*); with bird-like key (*l*).

Oblique line. These layouts (figs. 78, *b*; 79, *g-l*) are also fairly common. As in Glaze I panels, a line or set of lines join diagonally opposite corners, the other two corners of the panel being cut off and blacked. The oblique lines, however, are less carefully run into the angles and in some cases they are set well away from the angles (fig. 79, *i*, *j*), thus seeming to have been an afterthought, rather than a structural subdivision. The lines are ticked (*i*), dotted (*j*), fringed with small triangles (*h*) or left unadorned (*l*). A reminiscence of the Glaze I dotted checkerboard strip is seen in *k*.

Corner lines (figs. 78, *c*; 80, *a*, *b*). This simple arrangement is not well represented in the decorations of the whole vessels, but the sherds indicate that it was very often used. It consists of cutting off diagonally opposite corners of the panel by means of two parallel lines, the resultant triangular fields being filled solidly with glaze.

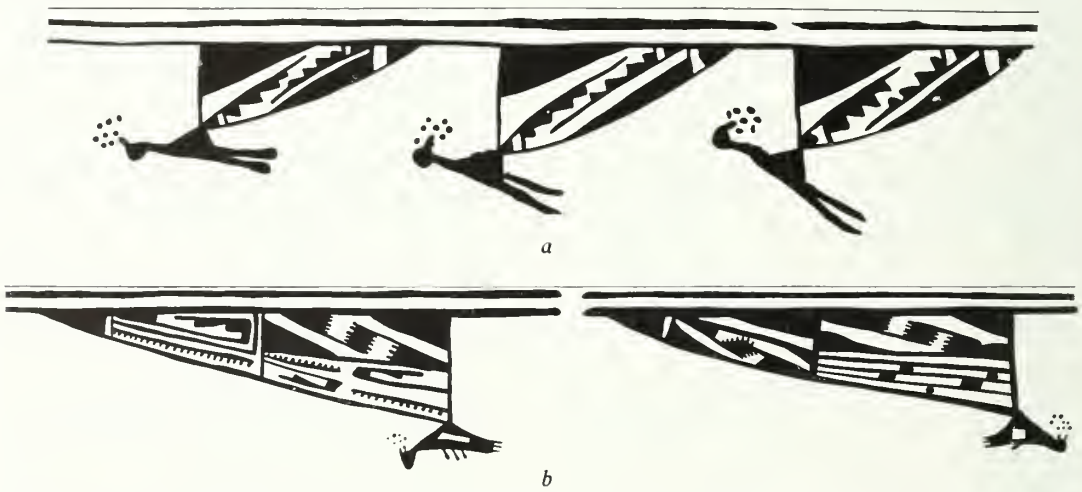


Fig. 82. Glaze II. Pendent triangle patterns. The bowl bearing pattern *a* has a single X on the exterior; the exterior of *b* is unornamented. (1/8)

Vertical-oblique cross (figs. 78, *d*; 80, *c-f*). A very frequently used framework, produced by drawing a vertical line in the middle of the panel and crossing it with a second line connecting diagonally opposite corners. The remaining two corners were cut off by short lines parallel to the long oblique line, and the four triangular fields so produced were blacked, leaving two equal parallelograms in reserved background. Examination of brush marks on the vessels and sherds shows that the above procedure was usually followed. In many cases, however, the long oblique line was replaced by two short lines originating above and below the middle of the vertical central line (fig. 80, *e*, *f*). Such panels are therefore, in reality, composed of two small panels of the corner line type.

Double opposed triangles (figs. 78, *e;* 80, *g*, *h*). Fairly common. In general effect this treatment is similar to the above, but as there is no central vertical line the reserved space between the opposed triangles is continuous.

Stalks for opposed elements (figs. 78, *f;* 81). A common treatment, ordinarily planned on oblique lines. The only non-oblique arrangement is seen in fig. 81, *a*, *b*, where large opposed keys are mounted on short stalks originating from the upper and lower banding lines. As a rule the stalks emanate from diagonally opposite corners of the panel, serving as bases for oblique keys (*c*, *d*), or as combined attachments for the very characteristic slung single key (*e-i*—this element will be described below) and the slung rectangle (*j*, *k*).

The above panel layouts are conventional. A few other treatments which, on the evidence of the sherds, do not deserve typical rank, are shown in figs. 80, *i-l;* 81, *l*.

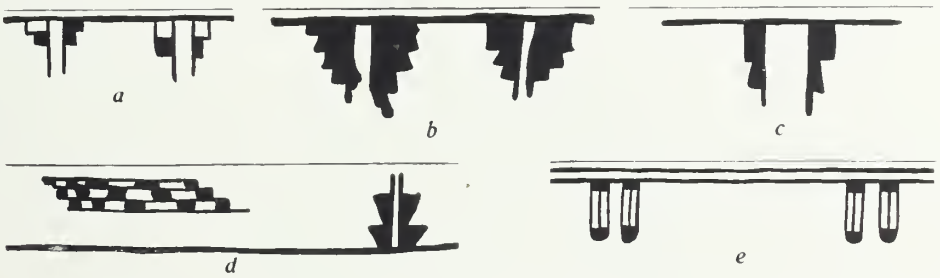


Fig. 83. Glaze II. Pendent key patterns. These seem to occur only in small bowls. *a:* Part of a pattern of six pairs of keys hanging from a line encircling the bowl. *b:* Short line with two pairs of keys (the rest of the interior is undecorated). *c:* Short line with single pair (repeated on opposite side of bowl). *d:* Variant, the keys rising from a base-line (design repeats once). *e:* Pendent feather (?) symbols (four sets in circumference of bowl). (1/8)

PENDENT TRIANGLE PATTERNS

There are but two examples among the whole bowls (fig. 82). The general arrangement is similar to that of the pendent triangle of Glaze I, but the execution is markedly inferior and the birds at the apexes of the triangles differ from those of Glaze I in that they are represented as pecking at seeds, as are certain birds upon Biscuit bowls (Vol. I, fig. 48, p. 98; fig. 82, p. 129).

PENDENT KEY PATTERNS

Pairs of key figures without stalks, set back-to-back, hanging from a line drawn close below the lip, are found in the interiors of several small bowls (fig. 83). The line may encircle the bowl, as in the specimen part of whose decoration of six pairs of keys is shown at *a;* or it may be a short line with one (*c*) or two (*b*) pairs of keys, the same short line and keys being repeated on the opposite side of the bowl.

The paired pendent keys seem to be restricted to Glaze II and to the at least partly contemporaneous Local Glaze I Red (cf. fig. 63).

ALL-OVER PATTERN

The strange decoration illustrated in fig. 84 provides the only example of an invasion of the bottom of a Glaze II bowl. The pattern consists of an interrupted band, or rather of two pendent rectangles akin to those of Glaze I (cf. fig. 11, *e*, *f*), the remaining space being occupied by a crudely drawn heart-shaped figure.

ELEMENTS OF INTERIOR DECORATION

LINES. The average width of the Glaze II line is about $\frac{3}{16}$ of an inch, an approximate doubling in weight of the line habitually used in Glaze I. Brushwork is also inferior, less care having been exercised to make edges straight and junctions accurate. The upper framer of the band was drawn with several strokes, three to five for the bowl's circumference, the work usually moving counter-clockwise.

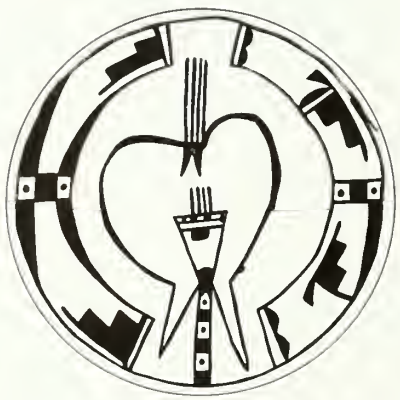


Fig. 84. Glaze II. All-over pattern, the only Glaze II example of this method of decoration. The exterior bears two pairs of dashes. (1/5)

The line was employed almost exclusively as a structural device. It assumes independence only in those panels which it crosses obliquely (fig. 79, *g-l*), when it is usually dotted or ticked. Neither hatching nor crosshatching appear. The stepped line, so very typical of Glaze I, is not found on any surely identifiable Glaze II specimen. This is an important difference between the two types.

DOTS AND TICKS. Sparingly used in series along lines (fig. 79, *g*, *i*, *j*). A single dot is sometimes placed in a small square or rectangular reserved space in a black strip (*a*), or in a "ladder-marked" strip (*k*). Neither dotted checkerboarding, nor any other form of checkerboard, is represented in the collection.

KEY FIGURES. It is remarkable that the stalked key with base (see fig. 25), employed in opposed pairs as a panel-filler, fails to be found on any whole Glaze II specimen, for this device is very common in Glaze I (figs. 16, 43) and by no means rare in Glaze III (fig. 115, *a-d*). What seem to be parts of such ornaments may be

made out upon sherds, and it is therefore probable that, in a form transitional between those characteristic of Glaze I and Glaze III, it was sometimes used.

Stalked keys without base (fig. 81, *a*, *b*). Commoner than in Glaze I. They occur in pairs in panels, relatively large two-stepped keys with long terminations and short stalks which are attached to the upper and lower banding lines in such a way as to bring the faces into direct opposition.

Unstalked keys. Pairs of keys, of somewhat variable form, but usually two-stepped, are set back-to-back as the principal decorative element of certain small bowls (see pendent key patterns, p. 97; fig. 83).

Unstalked oblique keys (fig. 81, *d*). Found on one bowl and several sherds. They come, as in Glaze I, from the corners of panels and do not differ, save in carelessness of execution, from those of the earlier type (cf. fig. 17, *i-n*).

Slung keys (fig. 81, *e-i*). This peculiar key, which is also common in Glaze III, makes its first appearance in Glaze II. I call it "slung," as I did in the case of the slung rectangle, because it is supported, so to speak, by two lines coming from diagonally opposite corners of the panel. Its structure can best be made out from the illustrations. The single key has one (fig. 81, *e*) or, more often, two steps (*f-i*). The figure is an awkward one, strangely out of accord with the strong Pueblo feeling for symmetrically balanced arrangements. It is hard to understand why it should have been preferred to the much more pleasing opposed keys, from which it would seem to have been derived. Yet, as has been said, it practically supplants opposed paired keys in Glaze II and is of equal, if not of greater, importance than are opposed paired keys in Glaze III. It is a very useful diagnostic of these two types.

Slung rectangles (fig. 81, *j*, *k*). Closely analogous in structure to the Glaze I figure of the same name, but more poorly drawn. Interior embellishment, save for the dot (*k*), is not seen.

Birds. In keeping with the general decorative poverty of Glaze II, birds are rare, save as ornaments for bowl exteriors and olla necks (see p. 102). The two pendent triangle patterns (fig. 82) bear avian forms which, both in structure and in position at the corners of the triangles, are like the birds from Glaze I. A likeness to Biscuit birds is to be noted in the groups of seeds at which they seem to be pecking; and in the realistic, two-mandible drawing of the bills of the birds in fig. 82, *b*. Presumably to be identified as birds are two figures which appear in alternate panels of a band design (fig. 76, *d*; enlarged in fig. 81, *l*). They are really stalked keys without base (cf. fig. 81, *a*, *b*) which have been made into birds by the addition to each of a single crooked line representing the head. I imagine that the decorator started out to paint two keys, but that observing the figures to be out of balance she added the crook; this is a typical case of the "realization" of a geometric figure. It may well be one of the first stages in the development of the Pajaritan bird, which appears in Glaze III and Glaze IV (see figs. 120; 149, *g-n*).

BOWL RIM DECORATION

Embellishment of the rim is extremely rare. The broad, flat lip of many Glaze II rims would have formed an ideal field for dotting or ticking, or even for

such more elaborate embellishments as zigzags, as it did, for example, in the case of the broad, flat lip of Mesa Verde bowls. But the Glaze I tradition of the unmarked lip held over and we have no bowl or sherd with embellishment upon this part of the rim. Neither was it a practice to ornament, as was so often done in Glaze III, the inner surface of Glaze II rims. Short, poorly drawn and inaccurately spaced lines appear upon this field in only a few cases (figs. 74, *e*; 75, *h*).

BOWL EXTERIOR DECORATION

There are two varieties of exterior decoration: simple devices, executed in glaze; and more elaborate figures in lustreless red paint outlined with glaze. Of our whole bowls, about 60% bear the simple glaze figures, 40% being embellished with red; approximately the same relative frequencies obtain in the sherds. Only two of our whole Glaze II bowls lack exterior decoration.

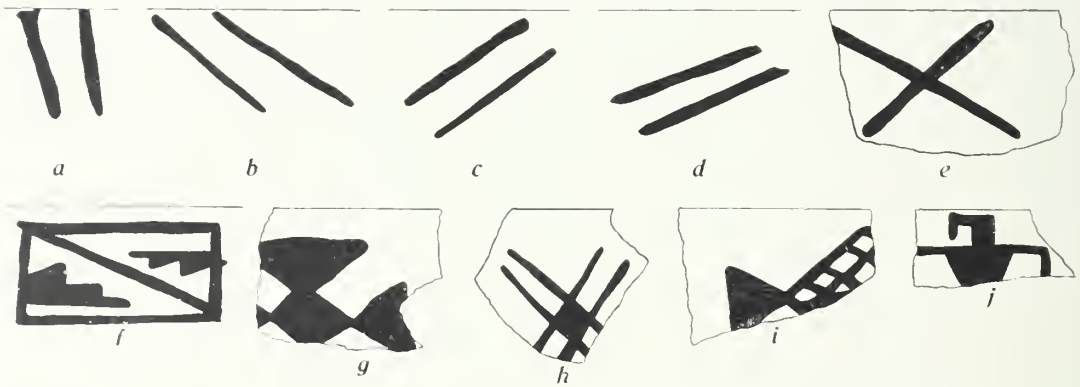


Fig. 85. Glaze II. Decorations in glaze from bowl exteriors. Pairs of dashes (*a-d*) repeated on opposite sides of the bowl are standard, X's (*e*) are rarer, and such figures as *f-j* are the only examples of more elaborate treatments to be found in the large sherd collection. (1/3)

SIMPLE DEVICES

These are similar to those of Glaze I. The most common arrangement consists of two pairs of dashes a couple of inches long, daubed carelessly on approximately opposite sides of the bowl running, usually obliquely, downward from the lip (fig. 69, *a'-c'*; 85, *a-d*). There is one case of three pairs and several of one. Crosses or X's (fig. 85, *e*) are much less common. Still rarer, but more often seen than in Glaze I, are such figures as are reproduced in fig. 85, *f-j*.

RED EXTERIOR FIGURES

Red exterior figures, which are characteristic of Glazes III to V, appear for the first time in Glaze II. They are large, boldly executed ornaments placed close

below the lip on the outsides of large bowls (figs. 69, *d'*; 70, *a'*, *b'*). The term "red-filled," which I once used in describing them,[1] is not strictly correct, for the red was always applied first and later outlined with glaze, as is proved by numberless instances of overlapping, and by a few specimens from which the glaze borders have been partly or wholly omitted.[2] The figures may be classified as follows:

Double-ended key figures
- Free-standing
  - Right-angled
  - Oblique
- Oblique double-ended keys on base-stripe
- Aberrants

Bird figures
- Tripartite tail
  - Free-standing
  - On base-stripe
- Miscellaneous birds
- Bird-tail symbol (?)

Other figures

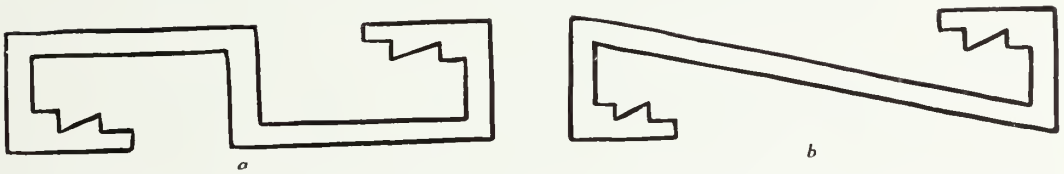


Fig. 86. Glaze II. Glaze-bordered red decorations from bowl exteriors. Schematic drawing to illustrate the right-angled (*a*) and oblique (*b*) variants of the double-ended key figure.

Whole Glaze II bowls with red exterior decoration were not recovered in sufficient quantity to yield significant evidence as to the relative frequency of the above varieties. Study of the much more abundant sherd material indicates, however, that key-figures were distinctly commoner than birds, and that right-angled keys were much oftener used than oblique keys. The analysis of an unselected group of thick-rimmed Glaze II sherds illustrates this point:[3]

[1] Kidder, 1915, p. 443.

[2] Such unmargined figures are notably weak and characterless. Throughout Southwestern ceramic art there is a strong tendency to border all colored areas with black to give them definiteness and "snap".

[3] Because the sherds usually carry only small parts of the figures, it is impossible to make minor distinctions. One can seldom determine, for example, whether an oblique key or a bird with tripartite tail was free-standing or attached to a base-line.

Double-ended key figures	40
Right-angled	29
Oblique	11
Birds	16
Other figures	7
	63

Double-ended keys, free-standing, of the right-angled sort have two two-step heads which are brought into opposition to each other, one up, one down, by four right-angle bends of their common stalk (fig. 86, *a*). In the obliquely planned variant the same position of the heads is attained by two bends of the stalk and a sloping middle portion (fig. 86, *b*). The heads of both sorts are characterized by a fairly short, right-angled termination, a relatively long outer step which slants angularly inward, and a very short, almost square basal step (fig. 87). There is some variation from this form, generally the result of careless painting. A few examples (as fig. 88, *c*) have three saw-tooth steps. The termination is always right-angled. The double-ended keys occur, as a rule, in pairs, the two units occupying most of the circumference of the bowl (fig. 88, *a-d*).

Fig. 87. Glaze II. Typical head from double-ended key. Note oblique face of the outer step and squareness of the inner step. From a sherd. (1/2)

Oblique double-ended keys on a base-stripe[1] are reproduced in fig. 88, *e*, *f*. They do not differ from the free-standing oblique figures save in being attached to, or rather arising from, a red stripe which encircles the bowl without exit space. We recovered specimens with two (*e*) and three (*f*) units.

Aberrant key patterns appear in fig. 89. The heads rise from a base-stripe (*b*), are formed by projections from two stripes (*a*), or hang in sets of three from two short stripes (*c*).

Bird figures with tripartite tail form a rather homogeneous group. Whether free-standing (fig. 90, *b*, *c*, *d*) or arising from a base-stripe (*e*, *f*), they face to the right (although there are sherds which suggest that left-facing birds sometimes occur). The head is a right-angled crook (*b*, *d*) or a simple downward projection from the straight neck (*e*, *f*). Only one example is provided with an eye (*f*). Legs are not represented. The tail consists of three straight bars, the upper one continuing

[1] In the discussion of Glazes II, III, IV, and V, I use the term "stripe" to describe a heavy red line bordered with glaze.

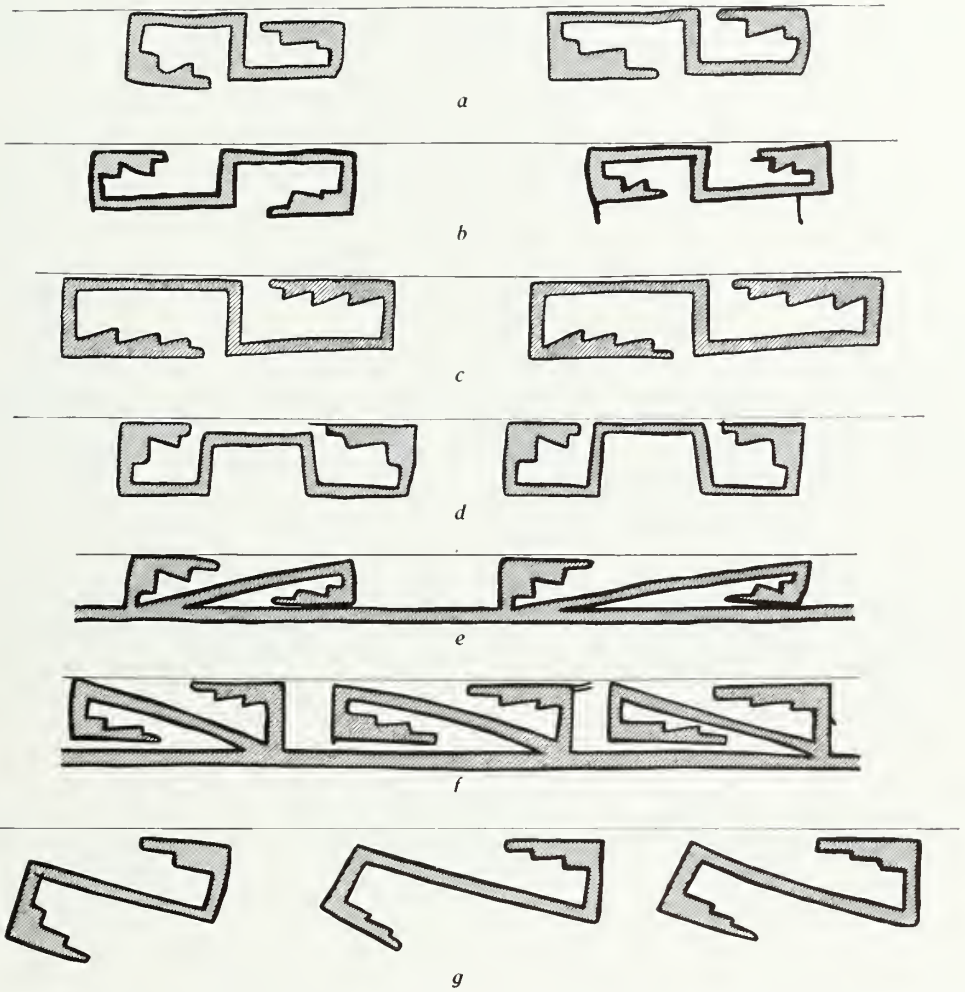


Fig. 88. Glaze II. Glaze-bordered red double-ended key decorations from bowl exteriors. *a-d:* Right-angled type. *e, f:* Oblique type rising from a base-line. *g:* Oblique type, free-standing. For interior pattern of *a*, see fig. 76, *c;* of *c*, fig. 76, *e;* of *d*, fig. 76, *b;* of *e*, fig. 76, *a;* of *f*, fig. 83, *c*. The interior patterns of *b*, *g* are too badly worn for reproduction. (1/8)

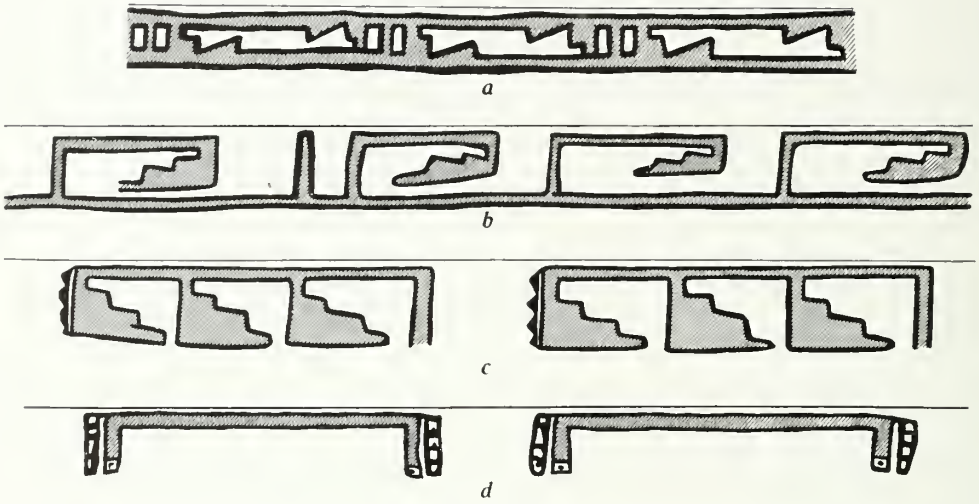


Fig. 89. Glaze II. Glaze-bordered red decorations from bowl exteriors, unusual arrangements. For interior pattern of *c*, see fig. 76, *d*; the interior patterns of *a*, *b*, *d* are not reproduced. (1/8)

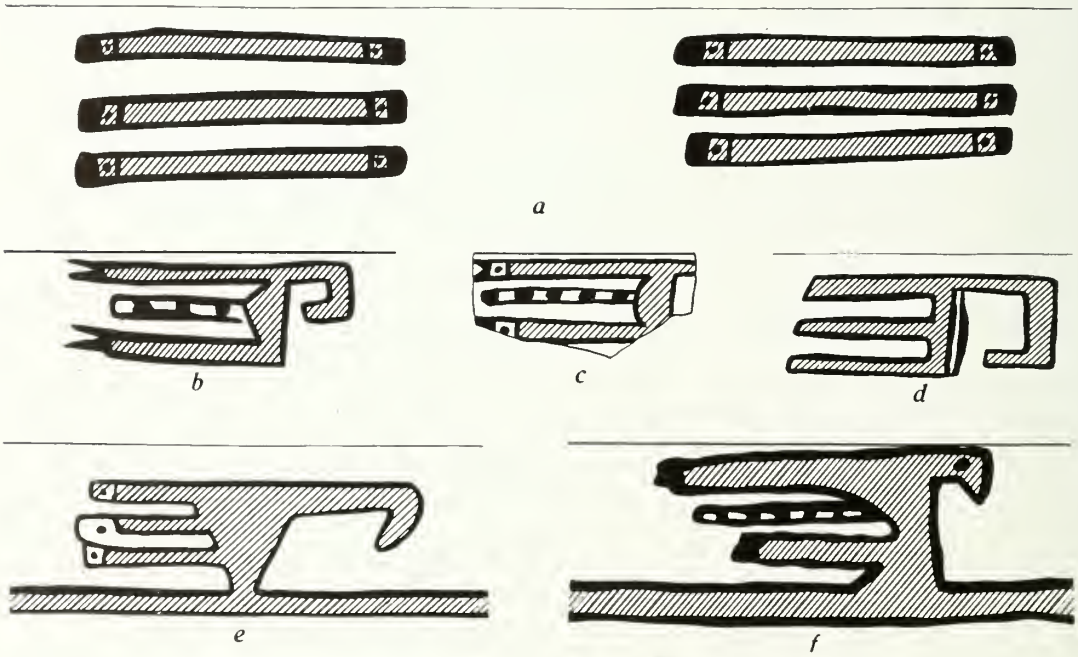


Fig. 90. Glaze II. Glaze-bordered red decorations from bowl exteriors. *a:* Bird-tail symbols (?). *b*, *c*, *d:* Free-standing birds. *e*, *f:* Birds arising from a base-line. The symbol *a* is repeated three times on the bowl; the bird *b*, twice; *d*, once; *e*, three times; *f*, four times. For interior decoration of *a*, see fig. 76, *h*; of *e*, fig. 76, *g*; of *f*, fig. 76, *f*. (1/4)

the line of the back, the two others below and parallel to it. In the middle bar the red pigment is often replaced by a series of large glaze dots (*b*, *c*, *f*). Swallowtail terminations are sometimes seen on the upper and lower bars (*b*, *c*); and very frequently the ends of the bars are cut off by a cross-line, a single dot occupying the small square so produced (*c*, *e*; many sherds show this arrangement).

Bird-tail symbols (?). This guesswork identification of the three-stripe ornaments seen in figure 90, *a* is based on the number of the bars (three, as in the tails of the birds just described), and the close resemblance between their cut off and dotted ends and the similarly treated ends of the tail elements of some of the birds illustrated in figure 90 (*c*, *e*). We have but one whole vessel bearing this device, but on the evidence of the sherds it would seem to have been fairly common. In

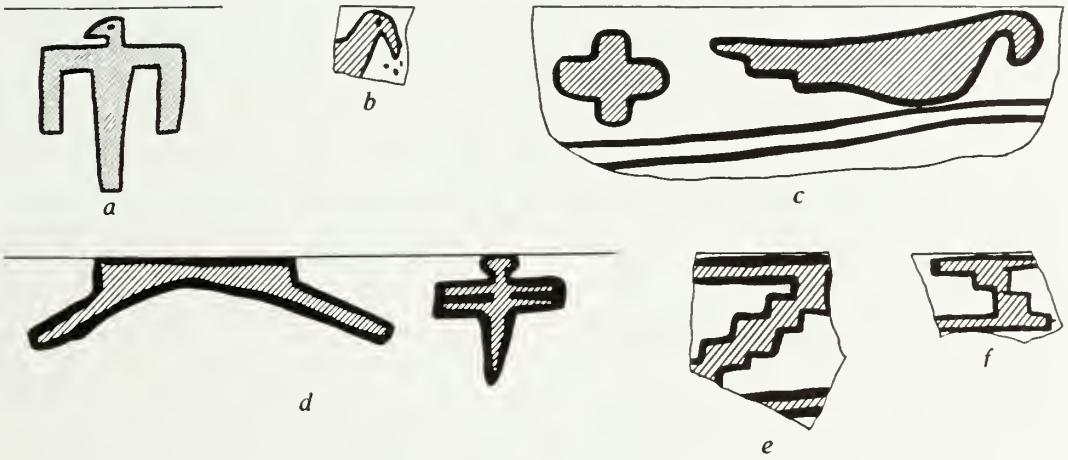


Fig. 91. Glaze II. Glaze-bordered red decorations from bowl exteriors. *a-c:* Birds. *d:* Dragon fly (?). *e*, *f:* Geometric patterns. From sherds. (1/4)

many cases, however, one cannot tell from a broken piece whether one is dealing with a part of this symbol or with the end of a bird tail. The left-facing birds postulated above may, indeed, be actually right-hand terminations of the device in question.

Miscellaneous birds. The spread-eagle bird in fig. 91, *a*, is unique, as is the head reproduced in *b* of the same illustration. The latter is represented as pecking at seeds, or so it would appear, as are many Biscuitware birds. Other examples of the same sort of depiction have already been noted in the pendent triangle patterns of Glaze II (cf. fig. 82). The bird in figure 91, *c*, from a sherd of a small bowl, is not duplicated in the Glaze II material.

Other figures. What seems to be a dragon fly (fig. 91, *d*) alternates with a two-pronged figure to form the exterior decoration of a small bowl. There is a cross behind the bird at *c*.

OLLA DECORATION

As to body decoration of ollas, there is, because of the extreme scantiness of our material, little or nothing to be said (see, however, the ollas of the same general period from other sites—fig. 72, *c-f*). Bands, it is evident, were exclusively employed. They seem not to have differed from the bands upon the interiors of bowls. The lower framing line is set at, or a trifle above, the point of greatest diameter, the upper one at the spring of the neck. The neck of the ollas was, apparently, almost always embellished with red figures,[1] exactly like those upon bowl exteriors: keys

Fig. 92. Glaze II. Neck decorations of Glaze II ollas; note close resemblance to the decorations upon the exteriors of bowls (cf. *a* with fig. 91, *f*; *b* with fig. 90, *b-d*.) (1/4)

(figs. 71, *a*; 92, *a*); birds with triparite tail (fig. 92, *b*). Thus begins in Glaze II a convention, rigidly adhered to throughout Glaze III and Glaze IV, that the body decoration of the olla shall follow that of the bowl interior; its neck decoration that of the bowl exterior. The same convention might, indeed, be considered to hold in Glaze I, for in that type both bowl exterior and olla neck are undecorated.

[1] Early examples, as fig. 71, *b*, sometimes had plain necks. It is so difficult to distinguish between undecorated Glaze II olla necks and the necks of Glaze I Yellow ollas, that no valid statistics can be given.

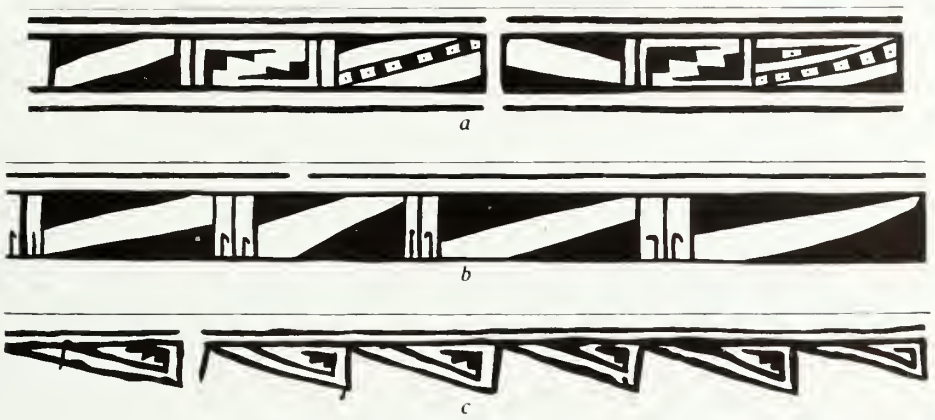


Fig. 93. Glaze II(?). Interior patterns from three bowls which are difficult to classify. Glaze II traits: poor glaze; simple decoration; mediocre brushwork. Glaze I Yellow traits: pairs of dashes as exterior decoration; thin vessel walls and unthickened rims; light slip covering exterior bottom. In the interior bottom of *b* and *c* are the dragon-fly figures reproduced in fig. 94, *a* and *b* respectively. (1/8)

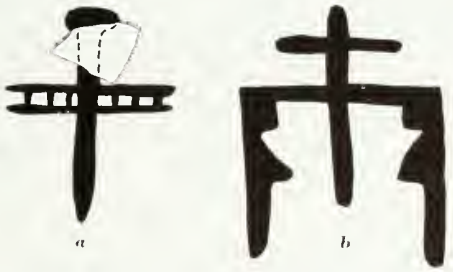


Fig. 94. Glaze II (?). Dragon-fly (?) figures from interior bottoms of bowls (cf. fig. 93, *b*, *c*). (2/3)

GLAZE III[1]

This important type developed so gradually from Glaze II that to establish a thoroughly satisfactory dividing line between the one and the other is impossible. There came a time, however, as is clearly proved by the tests, when the last of such Glaze I characteristics as the unmodified bowl rim and the dash or cross decoration of bowl exteriors had disappeared; when the rims of bowls were always thickened on the inside well below the lip; and when red ornaments were invariably applied, both to the exteriors of bowls and to the necks of ollas. These changes I consider to mark the opening of the Glaze III period; its somewhat less vague termination is signalized by the introduction of red slips, by improvement in glaze paint as a decorative medium in that it permitted finer line work, and by the heightening and straightening of the bowl rim, all of which traits are typically Glaze IV.

Glaze III is included, with some Glaze II and all of Glaze IV, in Nelson's Type III, Three-color Glazed Ware.[2] The present type was segregated early in the Pecos excavations. It was called in the field notes "Pecos Frijolito," because of its resemblance to the probably somewhat earlier pottery from the Frijolito ruin. The first description was published in 1917.[3]

GENERAL CHARACTERISTICS[4]

Three-color polychromy, produced by the use of dark glaze and red paint upon light backgrounds, first appears at Pecos upon a few Glaze I Yellow vessels. It becomes common in Glaze II, in which group nearly half the bowls and apparently almost all ollas were so treated. But not until Glaze III does this system of embellishment reach the standardization of practically invariable use. Even then, however, as in Glaze II, the red is usually confined to the exterior of the bowl and to the neck of the olla, bowl interiors and olla bodies still holding to the older two-color arrangement.

Although it is thus not unreservedly given over to polychromy, Glaze III is the least restrained and the gaudiest, in the matter of color, of all Pecos pottery, for the slip, in spite of many failures, was obviously intended to be so light as to form a sharply contrasting background for the large, rich red figures which were placed upon the most noticeable parts of the vessels. Strikingly handsome pieces were

[1] Comparable material constitutes Mera's Group C, the type ware of which is "Espinoso Glaze-polychrome"; later examples of Pecos Glaze III would be classified by Mera, on the basis of bowl rim profile, as "San Lazaro Glaze-polychrome" of his Group D (see first two profiles in cut on p. 6, Mera, 1933).

[2] Nelson, 1916, p. 173. The vessels designated Type III in his pl. VII are comparable to Pecos Glaze III.

[3] Kidder, M. A. and A.V., 1917, p. 334. Nelson's specimens are in the American Museum of Natural History; the Pecos collection is in the Museum of New Mexico and at Andover. Much sherd material from various sites is contained in the survey collection of the Laboratory of Anthropology at Santa Fe.

[4] For Miss Shepard's technological description, see pp. 506-509.

Fig. 95. Glaze III. Bowls. *a*, *b:* Typical examples of Glaze III. *c*, *d:* Late Glaze III bowls (Diam. of *d*, $13\frac{1}{4}$ inches)

sometimes achieved. In our collection, however, they are mostly represented by sherds, because in Glaze III at least, the Pecos unfortunately seldom used their finest bowls as mortuary offerings. The aim of the Glaze III potter was evidently to produce clear, very light-colored surfaces. The slips, at their best, are a beautiful creamy white. But the ideal was relatively seldom achieved, the average background being of a much duller shade, extremely difficult to characterize, because so subtly variable, but marked, in contrast to the slips of Glaze I Yellow and Glaze II, by a graying which, in the case of fire-clouded areas, becomes a dull, slaty blue. Yellowish and pinkish slips are also seen. And toward the end of the period there began to come into fashion a warmer brownish-red which foreshadows the slip colors of Glaze IV.

The slip is a relatively heavy coat, which covers the underlying paste so effectually that the latter's reddish color seldom shows through. It also adheres well to the surfaces of vessels; pieces with slip completely worn away, so common in Glaze II, are seldom seen. Flaking is unusual, crackling is absent. Finish is uniformly good, but extremely seldom excellent; never are surfaces truly glossy. Now and then we find a bowl with thin, streaky, "washy" slip such as occurs so often in Glaze II.

The glaze paint is markedly superior to that of Glaze II. Many lines, or parts of lines, are dull and untaken; the average luster, however, is good; occasionally high. In color the glaze is a deep brown-black, becoming greenish or yellowish brown where it is thin. Little yellow-rimmed craters appear in some particularly heavy applications. Running or spreading is unusual, the irregularity of many glaze lines being due, as can be discerned by careful examination, to careless manipulation of a coarse brush rather than to failure of the substance to lie as applied.

The matte pigment of bowl exteriors and olla necks is a rich red, Ridgway's Terra Cotta (7″) and Pecan Brown (11″*i*). It flakes more readily than does the slip; it is also softer and therefore more subject to wear.

Obvious firing clouds are not common. They only occur on the exterior. On light-colored bowls they have a slaty or bluish cast which is characteristic of Glaze III (between Ecru-Drab and Drab-Gray, 15″″*d*). Few pieces are evenly fired, almost every specimen showing variations of color. Bowl interiors are sometimes, though less often than in Glaze I and II, dulled and grayed from imperfect ventilation in burning.

VESSEL SHAPES

To the bowls and ollas, which were the only standard forms of decorated vessels made during Glazes I and II, there were added, in Glaze III, shouldered bowls, stirrup canteens, and certain small pieces with constricted orifice.[1]

BOWLS

The bowls (figs. 70, *c*, *d*; 95) are, on the average, better moulded than those of Glaze II. They are more nearly perfect circles, when seen from above; and, in pro-

[1] See p. 270 for discussion of stirrup canteens; p. 266 for the small pieces.

file, less often possess the slight lop-sidedness of many Glaze II specimens. The principal difference, however, is one of general contour (fig. 96, *a-c*). From a rounded bottom the sides of a Glaze III bowl rise in a gentle curve, like that of I and II, but the point of greatest diameter is well below the rim, there being a small, but distinct, incurve to the orifice. This results in a more rounded upper wall.

Measurements. In describing the Glaze I bowls, it was necessary to distinguish between large and small, because examples of intermediate size were absent. The same condition was found in the contemporaneous dull paint ware, Biscuit A.[1]

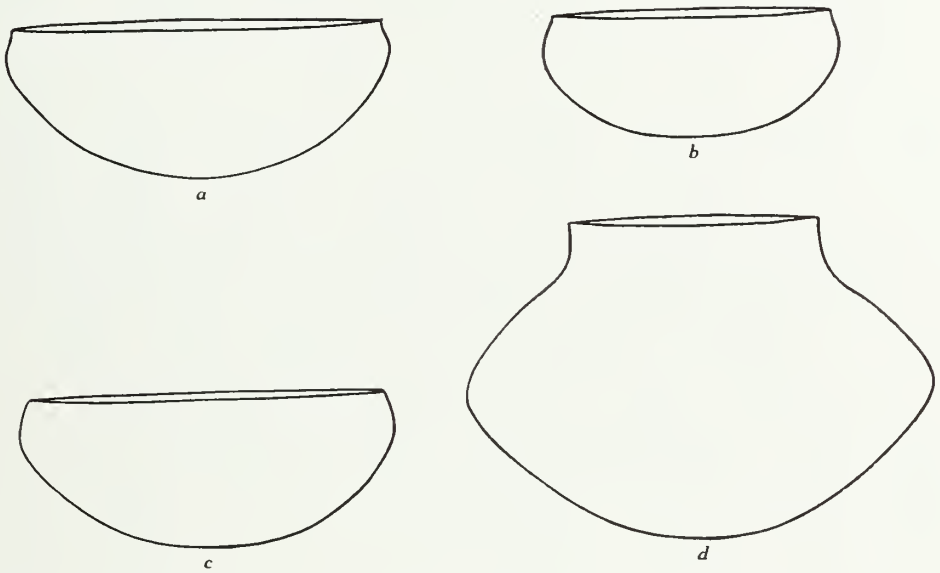


Fig. 96. Glaze III. Vessel shapes. *a-c:* Bowls. *d:* Olla. (1/6)

Glaze II bowls could still be divided into two groups on the basis of diameter, although small ones became more numerous and there was a certain representation of medium-sized specimens.[2] In Glaze III, a classification by size is not possible, for there is a complete gradation from the smallest to the largest.[3] We have two bowls between 6 and 7 inches in diameter; one between 7 and 8; seven between 8 and 9; eleven between 9 and 10 (the 8 to 10-inch bowl was practically absent from Glaze I, very rare in Glaze II); eighteen between 10 and 11; twenty-six between 11 and 12; eleven from 12 to 13. The two largest bowls measure 13¼ and 13½ inches in diameter, respectively. The 10- to 12-inch bowl was, accordingly, standard; the

[1] Vol. I, p. 76.

[2] See p. 81, above.

[3] It is interesting to note that a similar phenomenon took place in Biscuit B, which first appeared at Pecos during Glaze II (Vol. I, p. 102).

average of the seventy-eight measurable specimens is 10¾ inches. Depths run from 2¾ inches (for the 6-inch bowl) to 6¼ inches (a 12-inch specimen). The latter has an *orifice-depth index* of .52. The lowest index is .35; the average of all the Glaze III bowls is .41, almost the same as for Glazes I and II. *Capacities:* the 6-inch bowl, ¾ of a dry quart (.8 litres); the 13½ inch bowl, 6 dry quarts (6.6 litres); the standard 10- to 12-inch specimen about 3 to 4½ quarts (3.3 to nearly 5 litres).

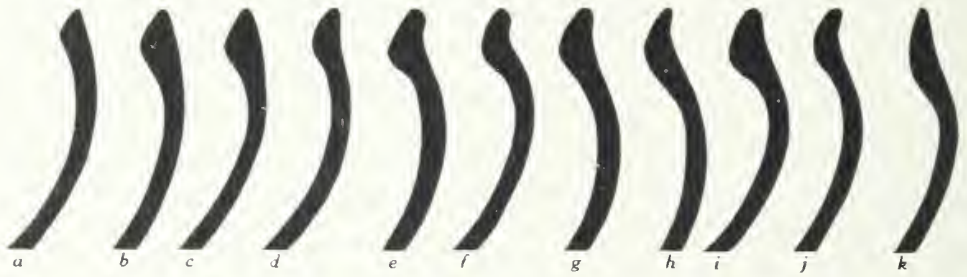


Fig. 97. Glaze III. Bowl rim profiles. Normal examples. Specimens *d-j*, with recurved exterior and pronounced thickening, are most abundant. Rims such as *a-c* without exterior recurve and with straight, downward-slanting inner face are early; those with high, relatively thin rim, such as *k*, are late. (1/2)

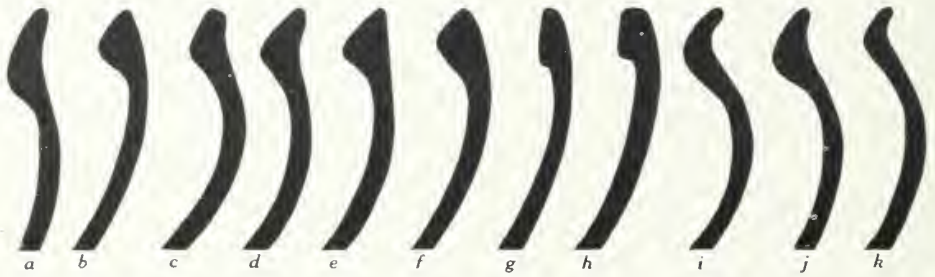


Fig. 98. Glaze III. Bowl rim profiles. Examples of aberrant form which, on criteria of color and decoration, are assignable to Glaze III. (1/2)

The *rim* of Glaze III bowls is an excellent diagnostic (fig. 97). There is almost infinite variation in the details of proportion, but the principal features are unmistakable: pronounced, low-set interior thickening; a gentle recurve of the exterior which approaches, but seldom reaches, a true flare; rounded lip; convex inner face, with relatively abrupt return from the point of greatest thickness to the point where the even curve of the vessel wall is resumed. The profiles *d* to *j* of figure 97 are typical. Specimens *a* to *c* represent a group which, both on stratigraphic evidence and on criteria of decoration, is certainly early. It is marked by lack of exterior

recurve, sharp rather than rounded lip, and straight inner face. Specimen *k*, on the other hand, with very slight exterior recurve, little thickening, and long, sweeping curves, is a late form. It occurs most commonly in pieces which in other ways approach the standards of Glaze IV. Figure 98 presents a selection of aberrants. *Thickness* of the vessel wall of Glaze III bowls is about ¼ of an inch.

OLLAS

As to the body shape of the Glaze III olla our information is scanty, for we have but two complete vessels and these differ considerably from each other. One of them (figs. 6, *b*; 96 *d*), however, I am inclined to believe a trade piece; the other fig. 6, *a*) seems, on the evidence of the sherds, to be typical of Pecos, though it is evidently smaller than the run of local ollas. Its lower body is full and the base is

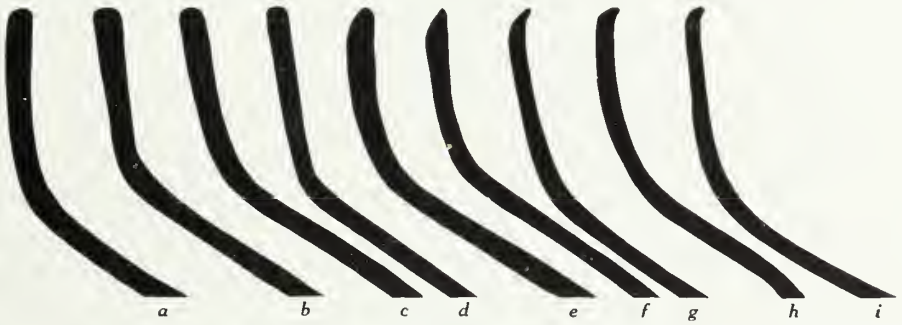


Fig. 99. Glaze III. Olla rim profiles. Note progressive softening of angle between neck and body; this is accompanied by a bevelling of interior of rim and, in late Glaze III, by a slight recurve at the orifice. (1/2)

rounded, but the shoulder is more angular than that of Glaze I examples. The neck rises almost vertically; the rim is direct, unthickened, with plain rounded lip. Of neck fragments we have a large collection. They indicate that the angle between upper body and neck is well-marked (fig. 99, *a-f*); less so, however, than in Glaze II (cf. fig. 73). The wall of the neck rises with little curve and usually only slightly inward from the vertical. The lip is flattish in what seem (on the basis of decoration, glaze, etc.) to be early specimens. In later necks there is first a rounding (fig. 99, *e*), then a bevelled thinning (*f*), and finally a slight outward recurve (*g-i*). The break between neck and upper body is least abrupt in the pieces with recurved lip. These closely resemble Glaze IV olla necks (cf. fig. 144).

Measurements of our one whole olla of local manufacture are: diameter of orifice 7½ inches, diameter at shoulder 13¼, height 9. Its *capacity* is 8½ dry quarts (9.3 litres). It is, as has been said, an unusually small specimen. The measurements of the probably imported olla are: diameter of orifice 7½ inches, diameter at shoulder

14½, height 10½, capacity 12½ dry quarts (13.8 litres). As to the diameter at shoulder and the height of the normal Glaze III olla we have no data; the orifice diameter, calculated from sherds, averages very close to 8 inches. The *thickness* of the vessel wall is about ¼ of an inch.

SHOULDERED BOWLS

These are the vessels which, in a former publication, I called "olla-bowls".[1] The latter term, however, is misleading, as the pieces in question have no real relationship to the olla. But a distinct shoulder, or pronounced point of greatest diameter well below the rim, they do possess (fig. 100). And they should certainly be distinguished from the standard bowl, because of their obviously intentionally restricted orifice, and because of the fact that they bear no interior decoration.[2]

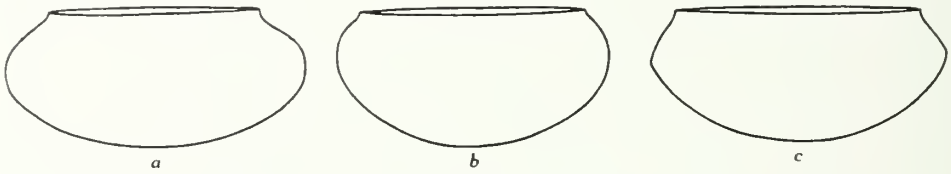


Fig. 100. Glaze III. Shouldered bowls. (1/6)

I have no evidence that the shouldered bowl was made at Pecos during Glaze II, although there is in the Peabody Museum collection from the Glaze II-III Frijolito ruin on the Pajarito Plateau a small rounded bowl with indrawn rim which might well be a prototype of the vessel as it first appears at Pecos in Glaze III. This initial Pecos form, which is distinctly rare, has a rounded shoulder whose point of greatest diameter lies well above the horizontal median line (about 65% of the height is below the shoulder).

Measurements of a typical specimen (fig. 102, *a*) are: orifice diameter, 7 inches; greatest diameter 8¾; depth, 4½. Its *orifice-depth index* is .64; *greatest diameter-depth index*, .51. Restorations from sherds show that this piece is of approximately average size and shape, although it seems to be a little higher than usual in relation to its diameter. Its *capacity* is 2½ dry quarts (2.8 litres).

The *rim* (fig. 101) differs from that of the standard Glaze III bowl in that it is rarely thickened (*a*). It usually turns sharply upward from the incurving vessel wall, becomes slightly thinner than the wall and terminates in a rounded lip (*b-e*). Direct rims, such as *g*, are unusual. In *thickness* the vessel wall averages somewhat less than that of standard bowls, 7/16 as against ¼ of an inch.

[1] Kidder, 1915, p. 422, pl. XVII, 3.

[2] Mera believes this form to have Little Colorado antecedents; specimens in his Group C (equatable with Glaze III) he calls "Kuaua Glaze-Polychrome." No rims exactly like those he figures have, however, come from Pecos (Mera, 1933, pp. 5, 6).

GENERAL DECORATIVE FEATURES

COLORS. Dark glaze on light background, exterior decoration of practically all bowls and interior decoration of a very few in dull red pigment outlined by glaze. A small percentage of bowls, most of which seem to be late, have reddish or brownish slips. Very rarely one of the dark-slipped pieces bears designs in white outlined in glaze; these are usually on bowl exteriors, but there are one or two cases (fig. 220, *b*) in which white invades the interior.

SLIP EXTENT. *Bowls:* light slip over whole interior and upper part of exterior; exterior bottom occasionally also slipped, but as a rule the red or brownish paste is left exposed in a circular area of varying size. The slip, toward the bottom, often

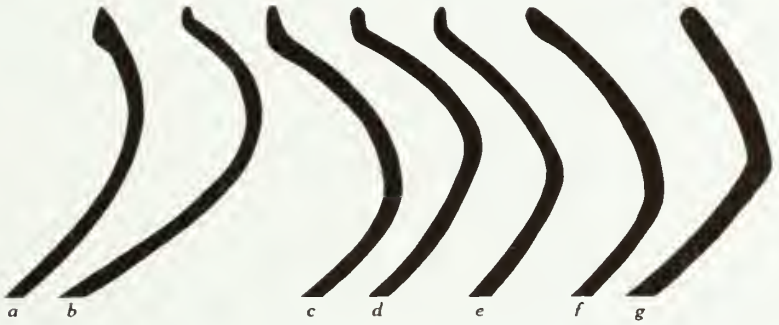


Fig. 101. Glaze III. Profiles of the upper parts of shouldered bowls. The rim at *a* approximates that of the standard Glaze III bowl (cf. fig. 97). The somewhat thinned standing rim and the rounded shoulders of *b-e* are typical. The angular shoulder of *g* foreshadows the Glaze IV form. (1/2)

becomes so thin and "washy" that the darker color of the paste shows through. In such cases there are clearly visible the marks of the broad swab implement with which it was applied.[1] The work was done with daubing strokes running roughly horizontally around the bowl. A careful lower edge was seldom achieved. In one case the slip was so liquid that it ran in dribblets downward over the bare paste of the bottom.

Ollas. The data are unsatisfactory, but it is ascertainable that in all cases light slip covers the exterior from lip to shoulder, i.e., point of greatest diameter. The light slip often runs inside the neck to its junction with the body and also

[1] Guthe (1925, p. 57) describes the slipping process at San Ildefonso as follows: "The mop with which the slip is applied is a folded cloth, about two inches wide and three, or three and a half, inches long. This is held at one end, between the thumb and the first two fingers of the right hand, the other end of the cloth acting as a two-inch wide paint-brush, which is manipulated with an easy backward-forward stroking motion parallel to the rim."

Fig. 102. Glazes III-V. Shouldered bowls. *a, b:* Glaze III. *c, d:* Glaze IV. *e, f:* Glaze V. Note progressive narrowing of the decorated zone. *g:* Shouldered bowl of Late Glaze V. *h:* Glaze V shouldered bowl with spout, a very rare form. (Diam. of *f* at shoulder, $10\frac{1}{4}$ inches)

covers the whole exterior bottom (as in the single whole specimen—fig. 6, *a*); sometimes, however, the base was left unslipped. In other cases the inner surface of the neck, and the exterior from the shoulder nearly to the base, are slipped red; in still others the inner surface of the neck is light, the bottom red (fig. 6, *b*).

Shouldered bowls. The methods of slipping are variable. Most commonly, it would seem, the entire vessel, inside and out, save possibly the very bottom, was covered with light slip. Other pieces bear light slip only from the point of greatest diameter to the lip, the exterior bottom and the whole interior being slipped red. As this is standard practice in Glaze IV and V, it is probable that the red slipped specimens are late.

Zones of decoration. *Bowls.* Normally the upper part of the interior from just below the rim-thickening downward for 2 to 4 inches; rarely the whole interior is occupied by an all-over pattern. Bowl exteriors bear free-standing repeated units, repeated units upon a base-stripe, or bands, all in glaze-bordered red and all set close below the edge of the rim, their width downward being variable, but seldom great enough to carry them below the limit of effective lateral visibility. There is no case of undecorated exterior. The rim bears, on its inner surface, various minor ornaments: ticks, zigzags, bird figures, etc. (see p. 140 and fig. 121).

Ollas (fig. 6, *a*, *b*). The neck provides a narrow field, which is always occupied by red, glaze-bordered figures. The upper body from the base of the neck to the point of greatest diameter forms a second, wider zone, decorated with glaze only.

Shouldered bowls (fig. 102, *a*, *b*). The exterior from point of greatest diameter to lip. The pattern may be in glaze-bordered red, or in glaze alone. The interior is undecorated, save for groups of ticks or oblique dashes applied to the inner side of the standing rim.

BOWL INTERIOR DECORATION

The patterns of ninety-three of our ninety-five whole, or nearly whole, Glaze III bowls were sufficiently well preserved for study. The overwhelming predominance of the band is made clear by the subjoined tabulation:

Bands	82
Zigzags (pendent triangles)	4
Pendent birds and keys	1
All-over patterns	6
	93

BAND PATTERNS

Framing. A single upper framing line, normally interrupted by an exit space,[1] lies between the band proper and the lip, but as a rule closer to the band than to the

[1] One cannot always be certain regarding this point, either because of damage to the framer by wear, or because a fragment which might have carried the line-break is missing. In drawing the designs of the few bowls in which such conditions exist, the framer has been reproduced with exit space. Whenever it is shown unbroken it is actually so in the original.

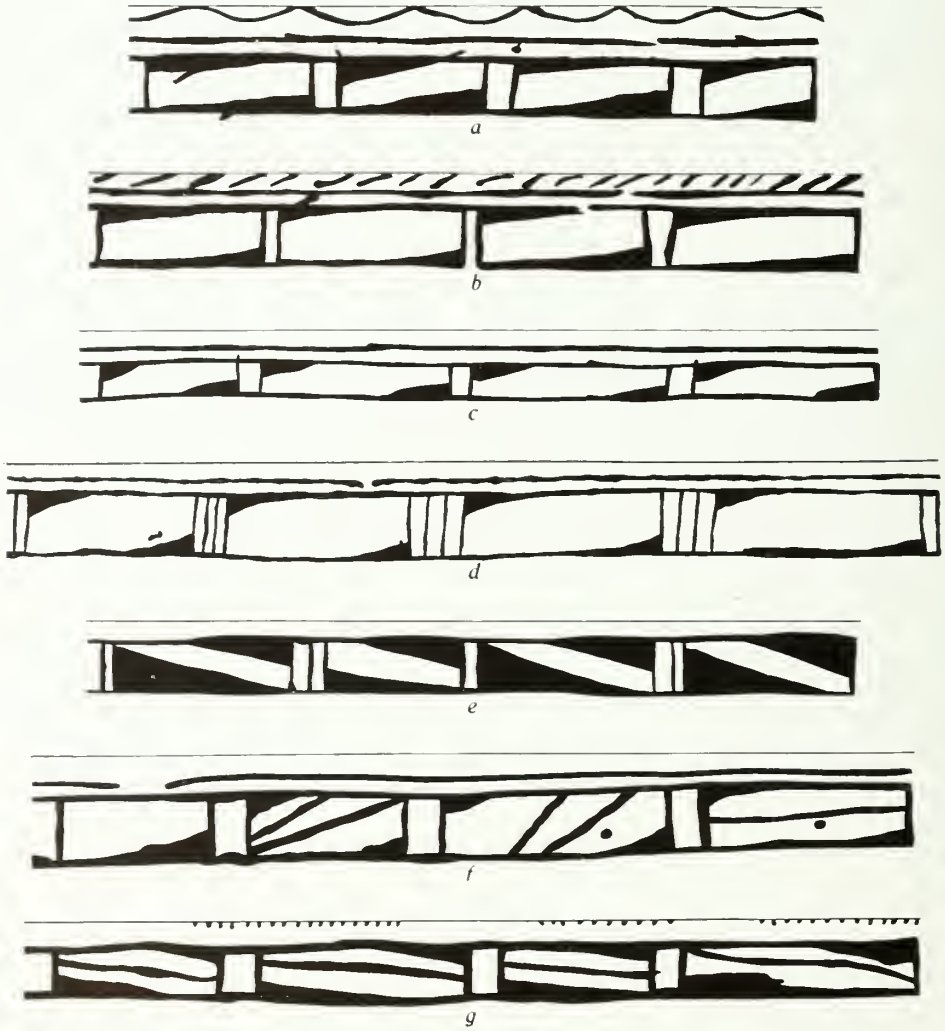


Fig. 103. Glaze III. Band patterns from bowl interiors; panels decorated in the "corner cut-off" manner. For exterior decoration of *a*, see fig. 133, *b*; for that of *b*, fig. 134, *d*; of *c*, fig. 130, *b*; of *e*, fig. 131, *f*; of *f*, fig. 131, *e*; of *g*, fig. 127, *a*. The exterior pattern of *d* was too worn for reproduction. (1/8)

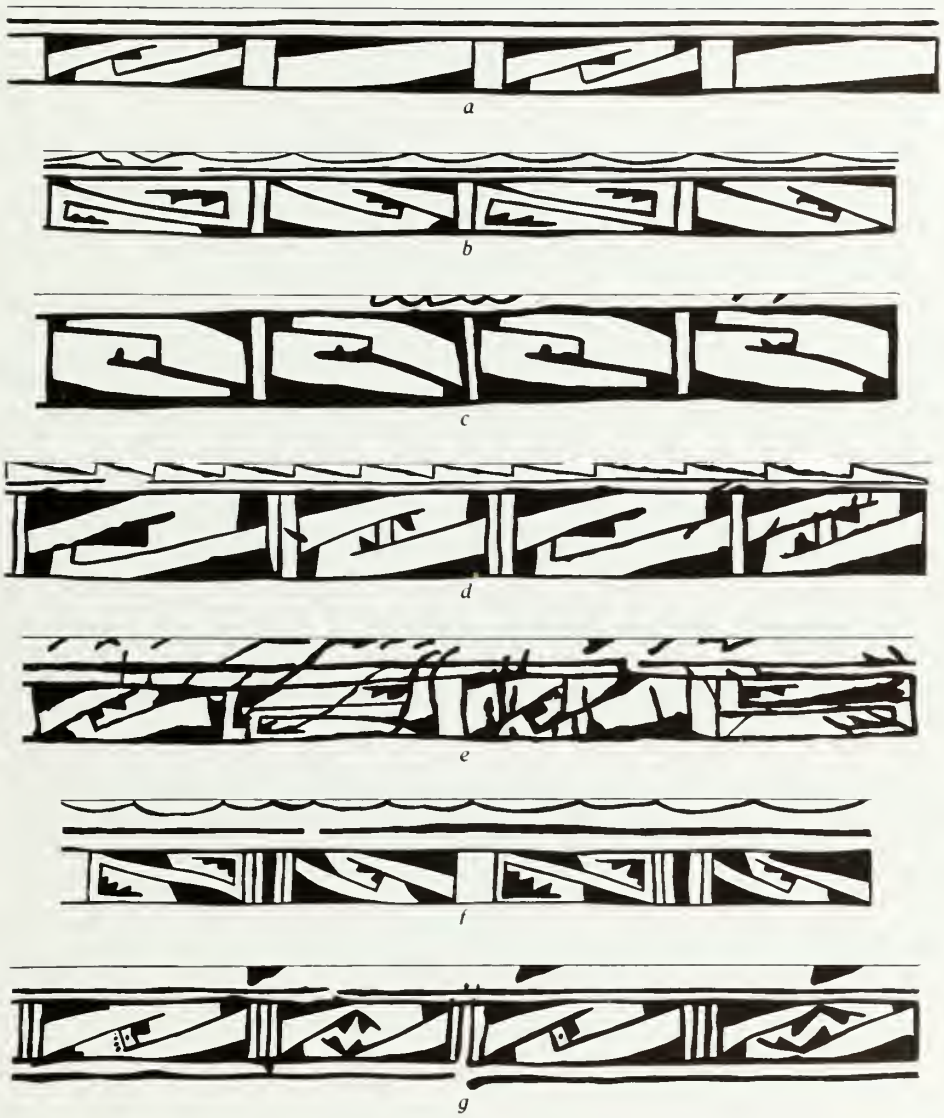


Fig. 104. Glaze III. Band patterns from bowl interiors; panels containing the slung key appear in each band. For exterior decoration of *a*, see fig. 122, *f*; for that of *b*, fig. 134, *c*; of *c*, fig. 133, *f*; of *d*, fig. 133, *d*; of *e*, fig. 122, *c*; of *f*, fig. 131, *b*; of *g*, fig. 127, *b*. (1/8)

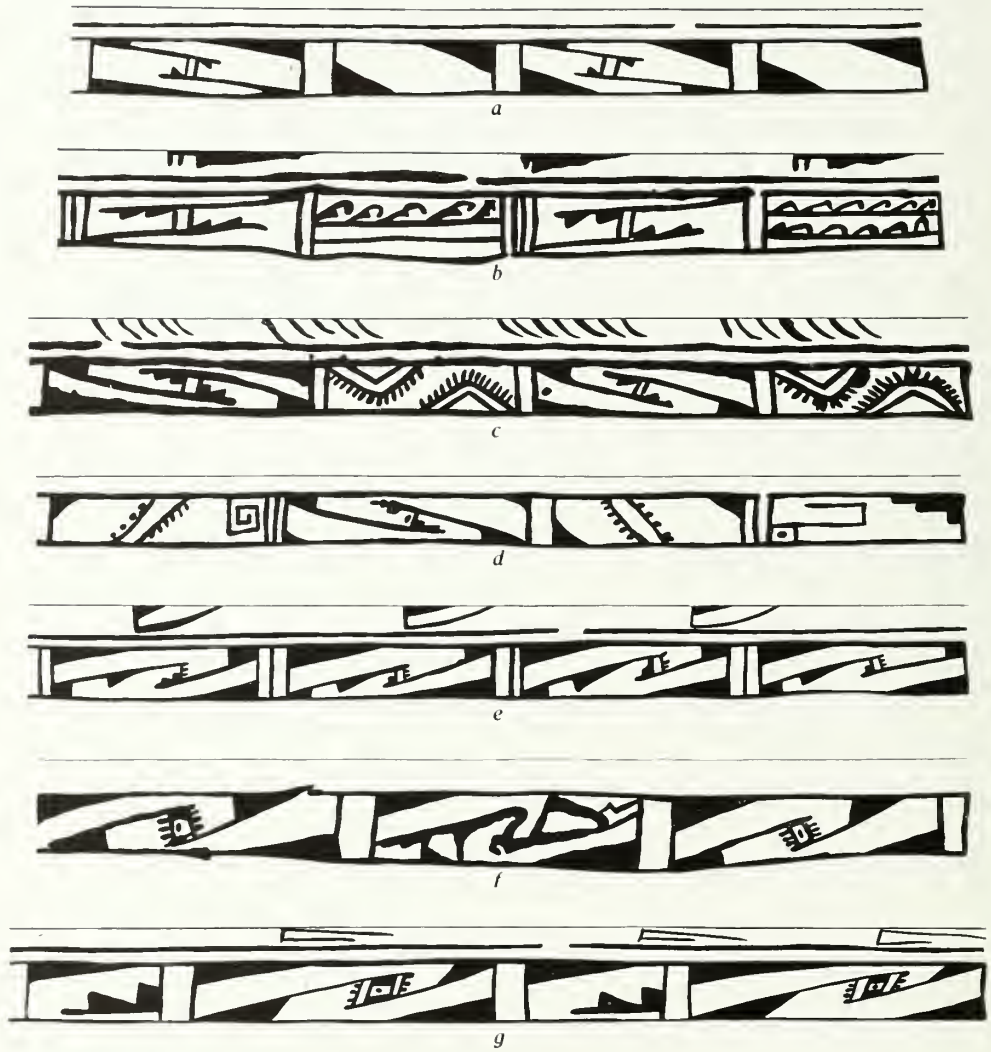


Fig. 105. Glaze III. Band patterns from bowl interiors; panels with slung double key and slung rectangle. For exterior decoration of *a*, see fig. 123, *c*; of *b*, fig. 134, *a*; of *c*, fig. 130, *h*; of *d*, fig. 130, *f*; of *f*, fig. 134, *h*; of *g*, fig. 127, *c*. The exterior decoration of *e* is not reproduced. (1/8)

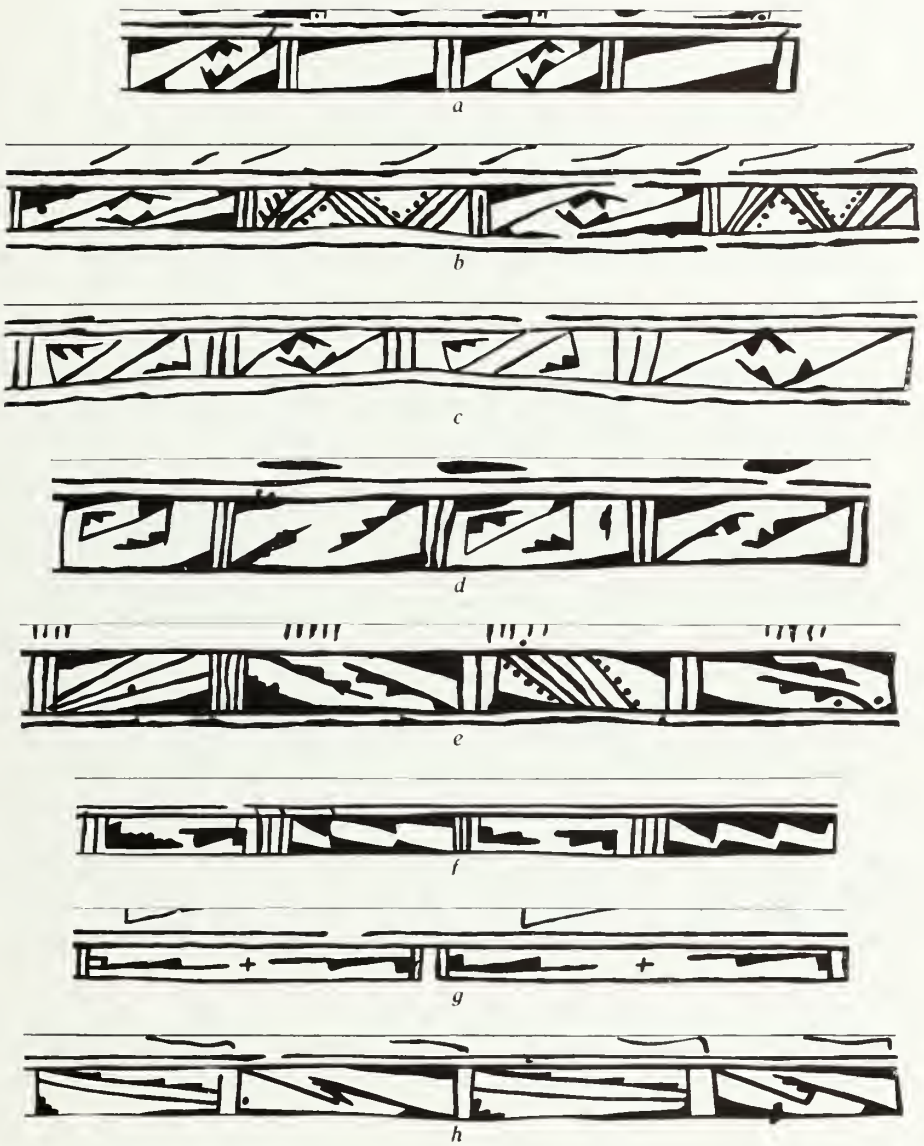


Fig. 106. Glaze III. Band patterns from bowl interiors; panels with opposed key figures. For exterior decoration of *a*, see fig. 123, *g*; of *c*, fig. 127, *i*; of *d*, fig. 124, *f*; of *e*, fig. 133, *g*; of *f*, fig. 133, *a*; of *g*, 129, *d*; of *h*, fig. 122, *b*. The exterior decoration of *b* is not reproduced. (1/8)

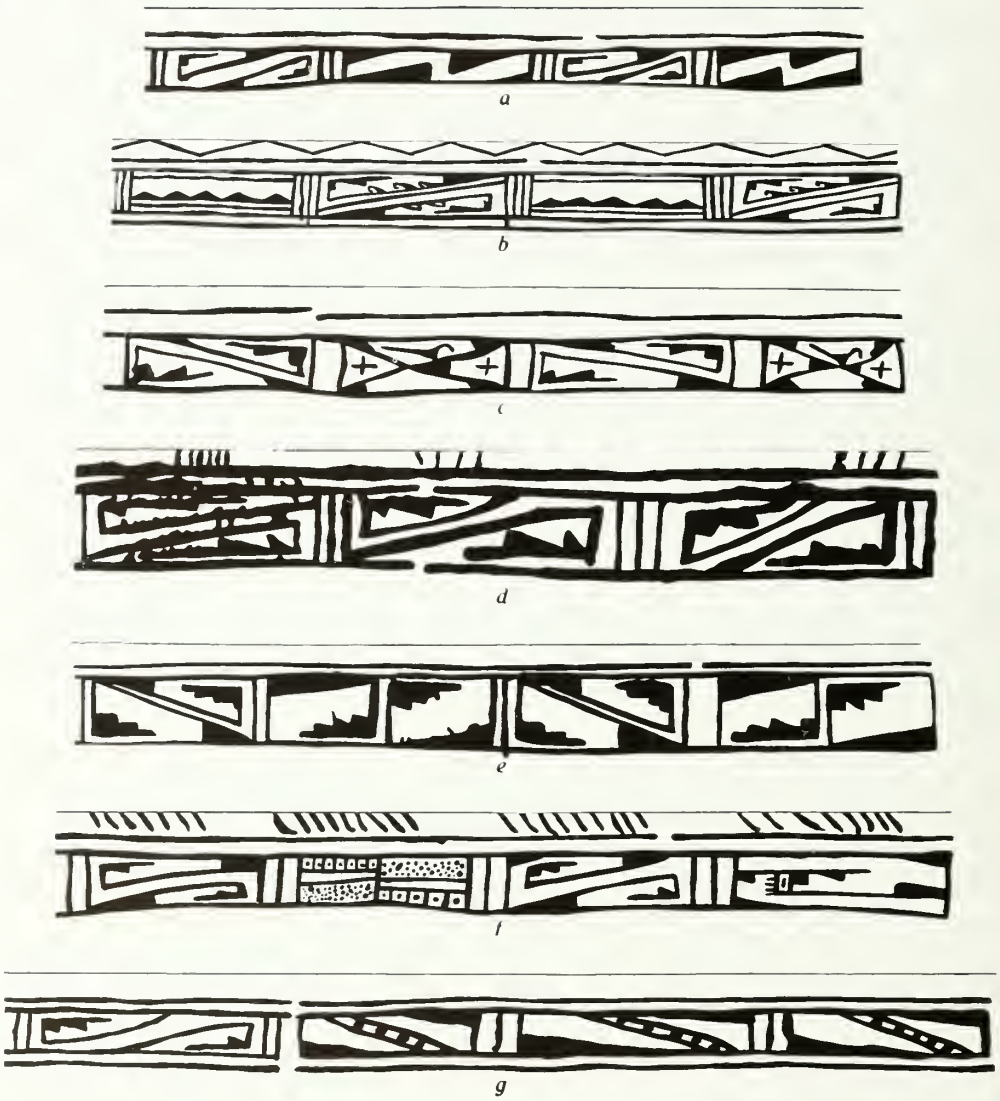


Fig. 107. Glaze III. Band patterns from bowl interiors; panels with indirectly opposed key figures. For exterior decoration of *a*, see fig. 129, *f*; of *b*, fig. 130, *e*; of *c*, fig. 123, *a*. The exterior decorations of *e*, *f* are not reproduced; that of *g* is shown in the photograph, fig. 95, *d'*. (1/8)

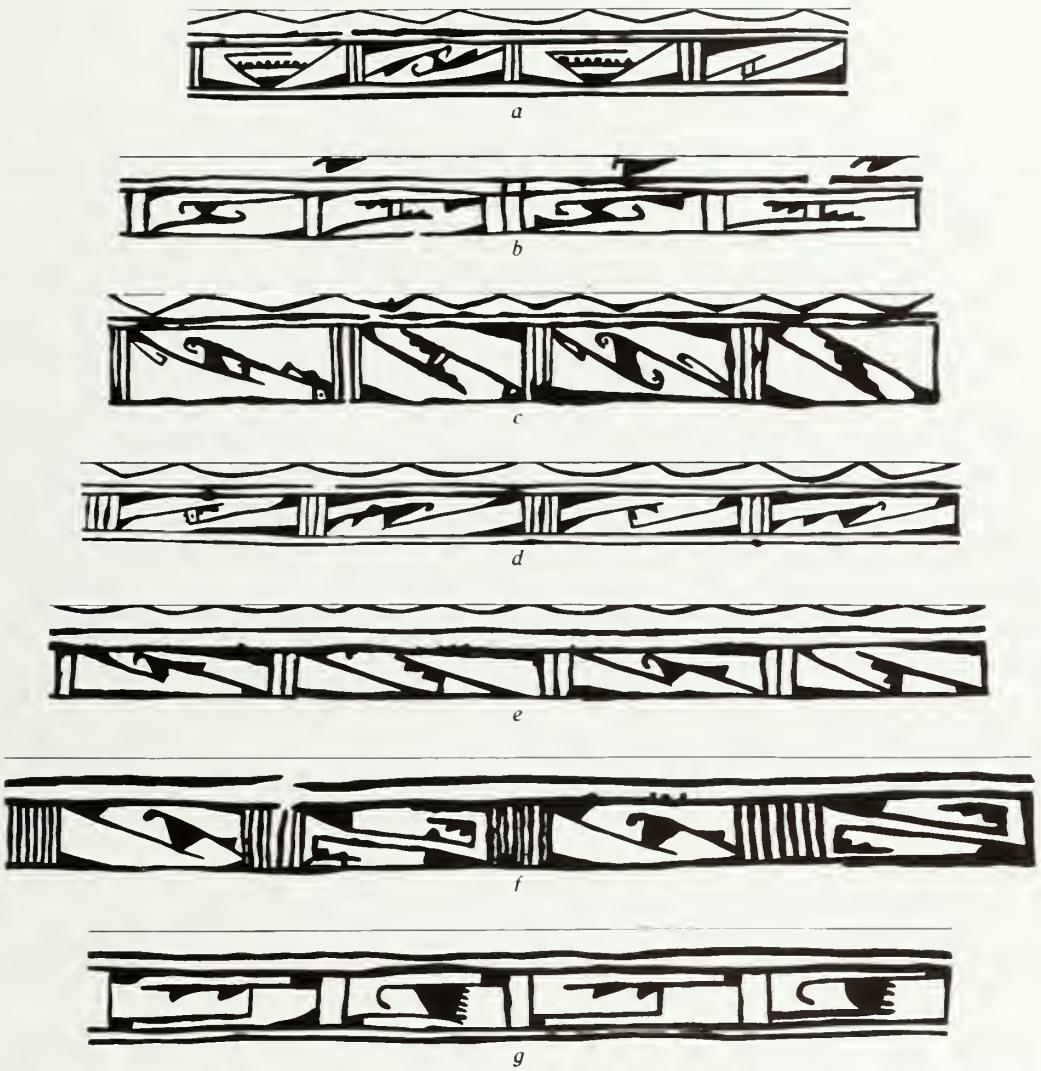


Fig. 108. Glaze III. Band patterns from bowl interiors; panels with slung bird figures: double (*a-c*), single (*d-g*). For exterior decoration of *a*, see fig. 129, *e*; of *b*, fig. 134, *g*; of *c*, fig. 134, *b*; of *d*, fig. 122, *a*; of *e*, fig. 124, *g*; of *f*, fig. 130, *g*; of *g*, fig. 131, *c*. (1/8)

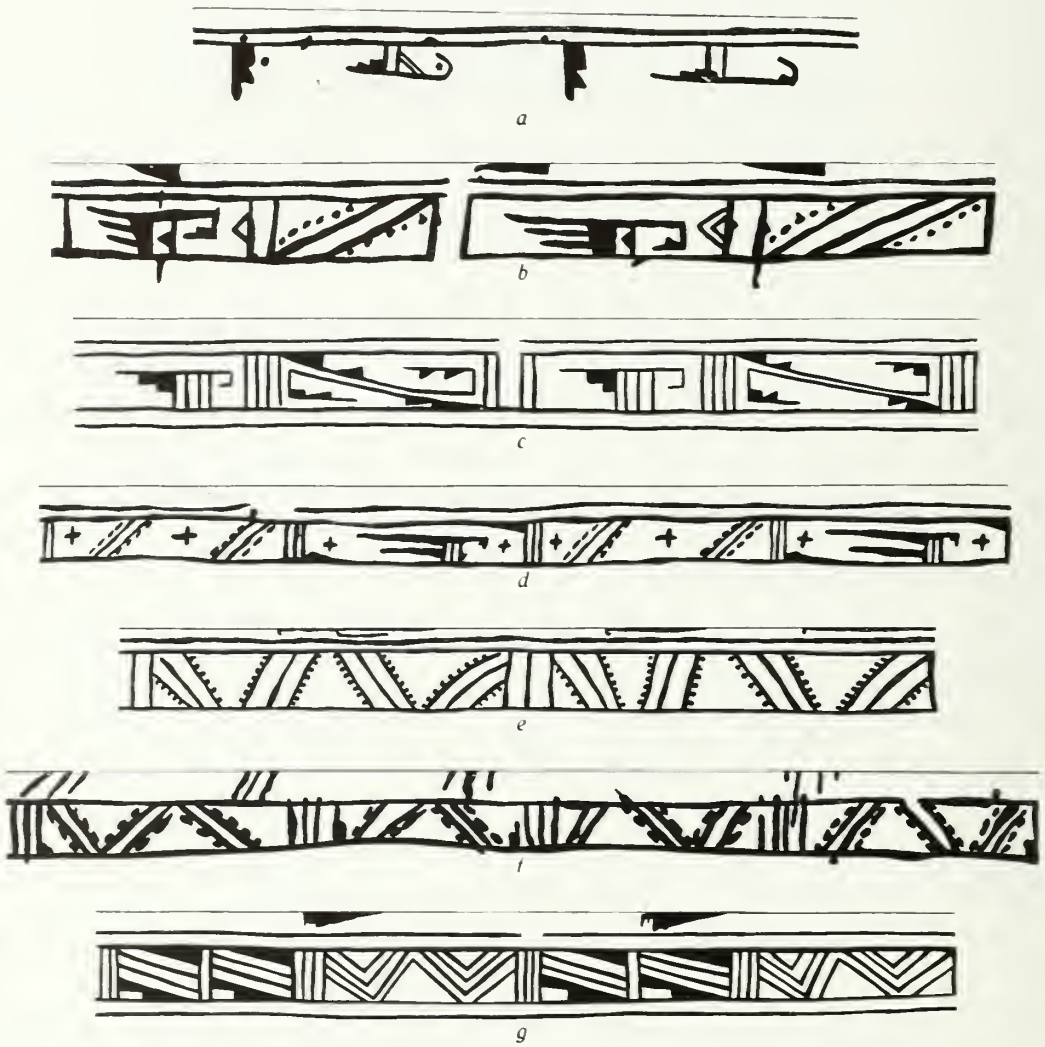


Fig. 109. Glaze III. Patterns from bowl interiors; all but *a* are bands. These patterns foreshadow Glaze IV decorative practice in the use of large bird figures and zigzags as panel fillers; and in the separation of the panels by multiple lines. For exterior decoration of *a*, see fig. 129, *h*; of *b*, 124, *d*; of *c*, fig. 127, *h*; of *d*, fig. 130, *c*; of *e*, fig. 127, *d*; of *f*, fig. 129, *g*. The exterior decoration of *g* is not reproduced. (1/8)

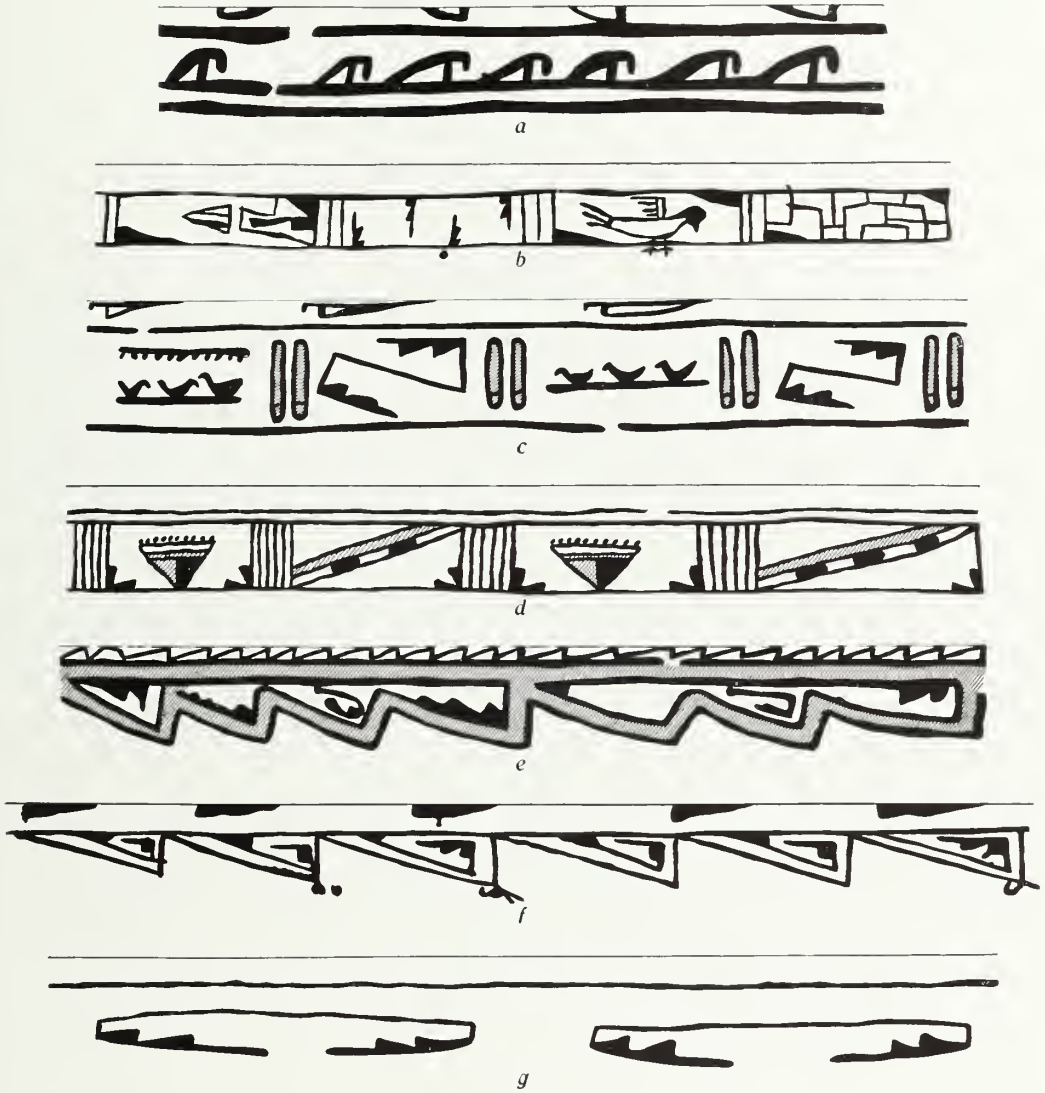


Fig. 110. Glaze III. Patterns from bowl interiors. *a-d:* Aberrant bands. *e, f:* Zigzags. *g:* Double-ended key figure in glaze. The use of red as an element of interior decoration, as in *c*, *d*, *e* is very unusual. For exterior of *b*, see fig. 133, *h;* of *c*, fig. 127, *f;* of *d*, fig. 127, *g;* of *e*, fig. 131, *d;* of *f*, fig. 124, *b;* of *g*, fig. 124, *c*. Exterior of *a* not reproduced. (1/8)

lip. It thus drops well below the approximately midway position which it occupied in Glazes I and II. This is of course due to the thickening of the rim, the framer naturally falling into position on the wall of the bowl at the base of the protuberant convexity of the rim's inner face. The line is of the same thickness as the banding lines. A bottom framer occurs in about 20% of all bands. This is a much higher percentage than obtains in the earlier Glazes, but is lower than in Glaze IV. The bottom framer is less regularly broken than is the upper one. The banding lines are seldom provided with an exit space.

Paneling. This method of subdividing the band is as closely followed as in Glazes I and II, eighty of the eighty-two patterns being so treated. The large sherd collection tells the same story. The panels are separated from each other in somewhat less than half of all cases by a simple open space (less broad, on the average, than in Glaze II) between two narrow, engaged paneling lines. There are five or six instances of an arrangement not hitherto seen, in which two of the inter-panel spaces are open, the two alternating spaces being occupied by a vertical central line (figs. 103, *e;* 105, *d*). In rather more than half of all bands the division is by sets of lines, three to eight in number; three and four are most consistently used; there is but one instance of six (fig. 110, *d*); one band (fig. 108, *f*) has three sets of seven and one of eight. In general, the bands with simple open-space paneling are found on bowls which, judging by rim profile, color and the details of decoration, are assignable to the earlier stages of Glaze III; while those with multiple-line paneling are, on similar evidence, late. An apparently atavistic throw-back to the heavy unengaged paneling bar of Glaze I is seen in two of the inter-panel spaces of the pattern reproduced in fig. 104, *f;* the bowl is otherwise a normal example of Glaze III. A highly aberrant device for producing panel-like spaces appears in fig. 110, *c*, where pairs of short vertical red bars outlined in glaze, which do not reach the banding lines, cut the band into four parts.

The number of panels is normally four; seventy-five of the eighty bands are so arranged. The five exceptions are: one band (not illustrated) of five panels of the corner-cut-off type (fig. 112, *g*); one of three (fig. 105, *f*); and three of two panels each (figs. 106, *g* and 109, *e*, the third not illustrated). In the four-panel bands two unlike pairs of panels usually alternate (A,B,A,B).

Panel layout. Analysis of the very abundant Glaze III material shows progressive continuation of the tendency observed in Glaze II toward reduction in the number of ways in which panels might be subdivided. Comparison of figs. 12 and 39 (Glaze I Red and Yellow) with fig. 78 (Glaze II) and fig. 111 (Glaze III) clearly illustrates this point. Methods of subdivision occurring more than once or twice are:

Horizontal line (fig. 111, *a*)
Oblique line (fig. 111, *b*)
Corner lines (fig. 111, *c*)
Double opposed triangles (fig. 111, *d*)
Stalks for opposed or slung elements (fig. 111, *e*)
Zigzag (fig. 111, *f*)

Horizontal line (figs. 111, *a;* 112, *a-e*). This is a relatively rare layout (seven examples on whole vessels). The designs achieved obviously hark back to earlier standards, as is indicated by the use of dots and dotted checkerboard strips. A horizontally planned panel reminiscent of the Glaze I simple and double cross arrangements is shown in fig. 112, *f*.

Oblique line (figs. 111, *b;* 112, *i-n*); commoner than the above, but not abundant (eight examples). The line or lines cutting diagonally across the field may be plain (fig. 112, *i, j*), ticked (*n*), edged with small triangles (*m*), or checkerboarded.

Corner lines (figs. 111, *c;* 112, *g, h*). This very simple treatment, in which two diagonally opposite corners of the panel are cut off and filled with glaze, occurs about twice as frequently as the foregoing (seventeen examples). The panels so produced, and those with the central oblique line, are generally used in series of four

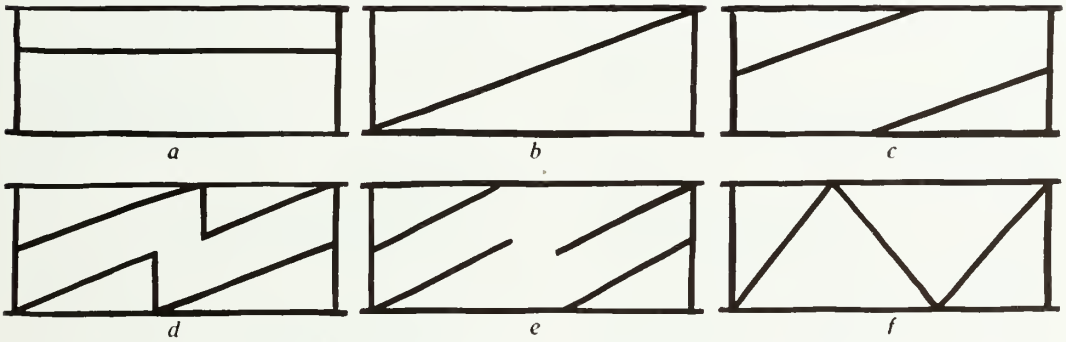


Fig. 111. Glaze III. Methods of panel subdivision. *a:* Horizontal line. *b:* Oblique line. *c:* Corner lines. *d:* Double opposed triangles. *e:* Stalks for opposed or slung elements. *f:* Zigzag. (Diagram)

to make up complete patterns (see fig. 103); they are seldom alternated with other types of panel (patterns in which they do alternate appear in figs. 104, *a;* 105, *a;* 106, *a*).

Double opposed triangles (figs. 111, *d;* 116, *a, b*) are rare (four examples). Three triangles are used once (fig. 116, *c*); and there is a single instance of the vertical-oblique cross (fig. 116, *d*), an arrangement whose layout is fundamentally different from that of the opposed triangles, but which also results in the production of triangles.

Stalks for opposed or slung elements (figs. 111, *e;* 113, 114, 115). This is the standard Glaze III method of panel subdivision. On the whole bowls, there can be counted at least seventy examples of its use, and study of the sherds confirms its preëminence. Two theoretically parallel lines emanate from diagonally opposite corners of the panel at such an angle that they pass each other. Their ends, or their sides, or the spaces between them, are decorated in a number of ways which will be described in the section dealing with the elements of Glaze III design (p. 136).

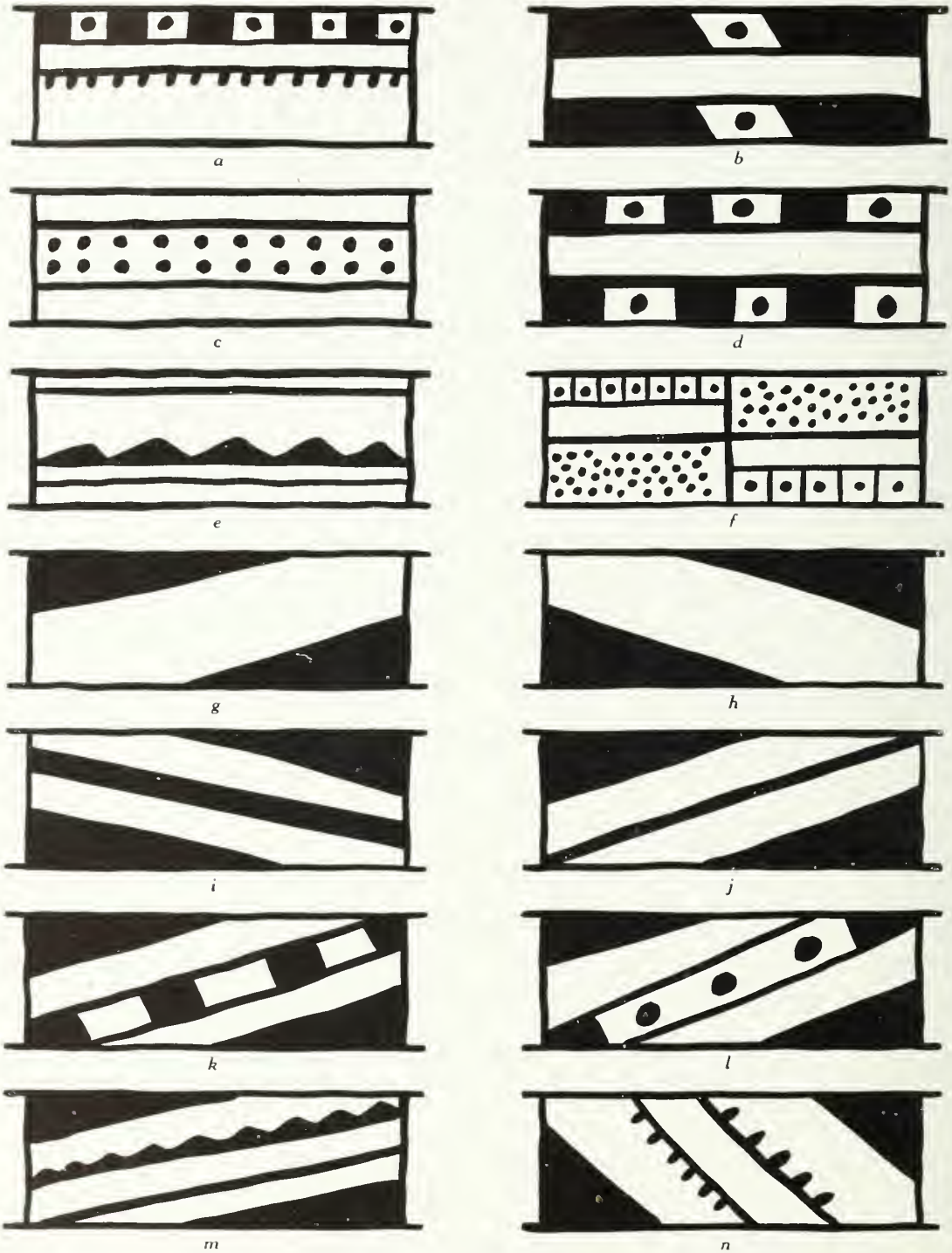


Fig. 112. Glaze III. Panels. *a-f:* Subdivision by horizontal lines. *g, h:* Corner-line subdivision. *i-n:* Oblique central line.

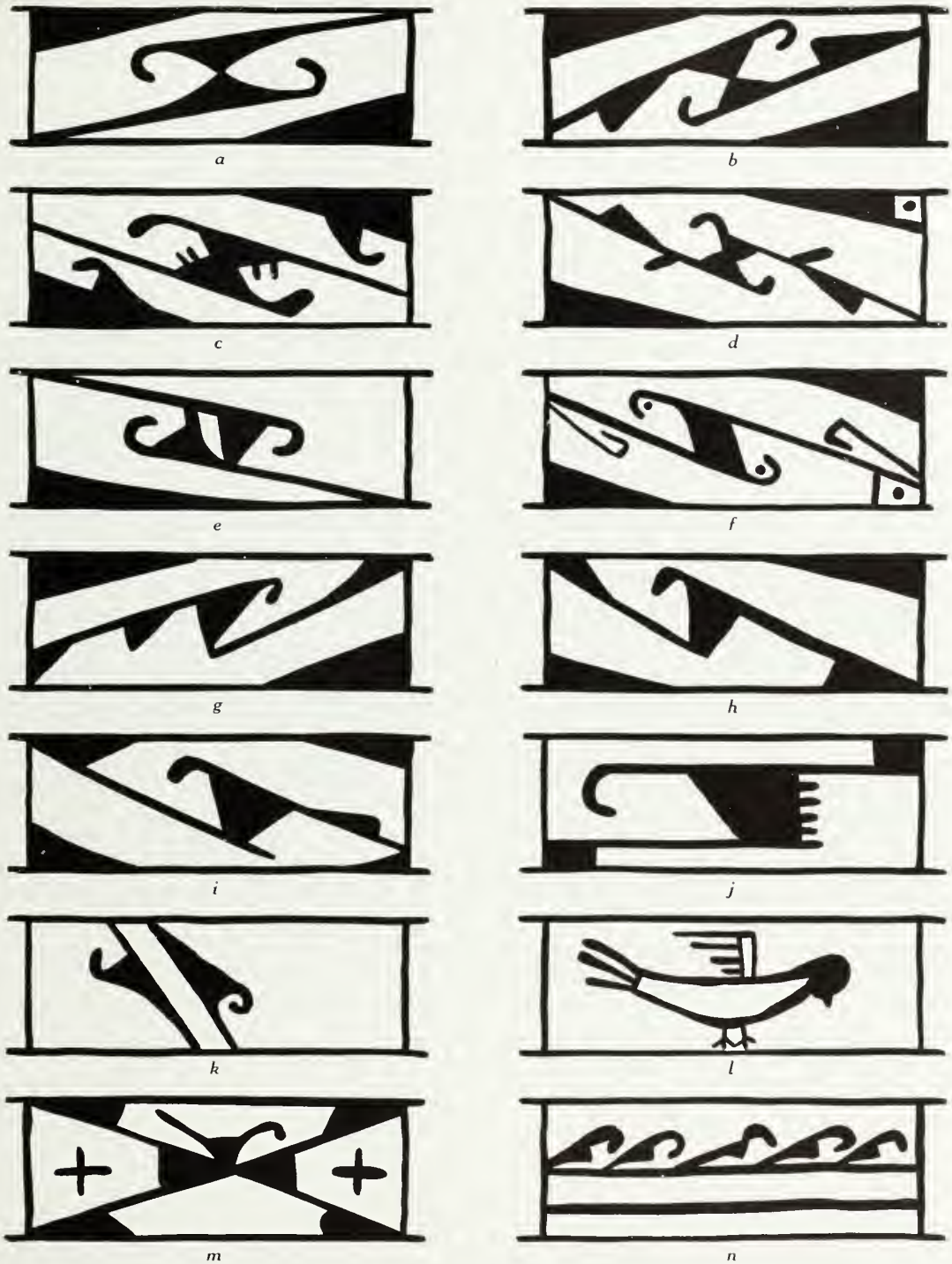


Fig. 113. Glaze III. Panels with bird figures. *a-f:* Slung double birds. *g-j:* Slung single birds. The basic layout of *a-j* is the same, i.e., by means of lines emanating from diagonally opposite corners of the panels. The treatments seen in *k-n* are atypical.

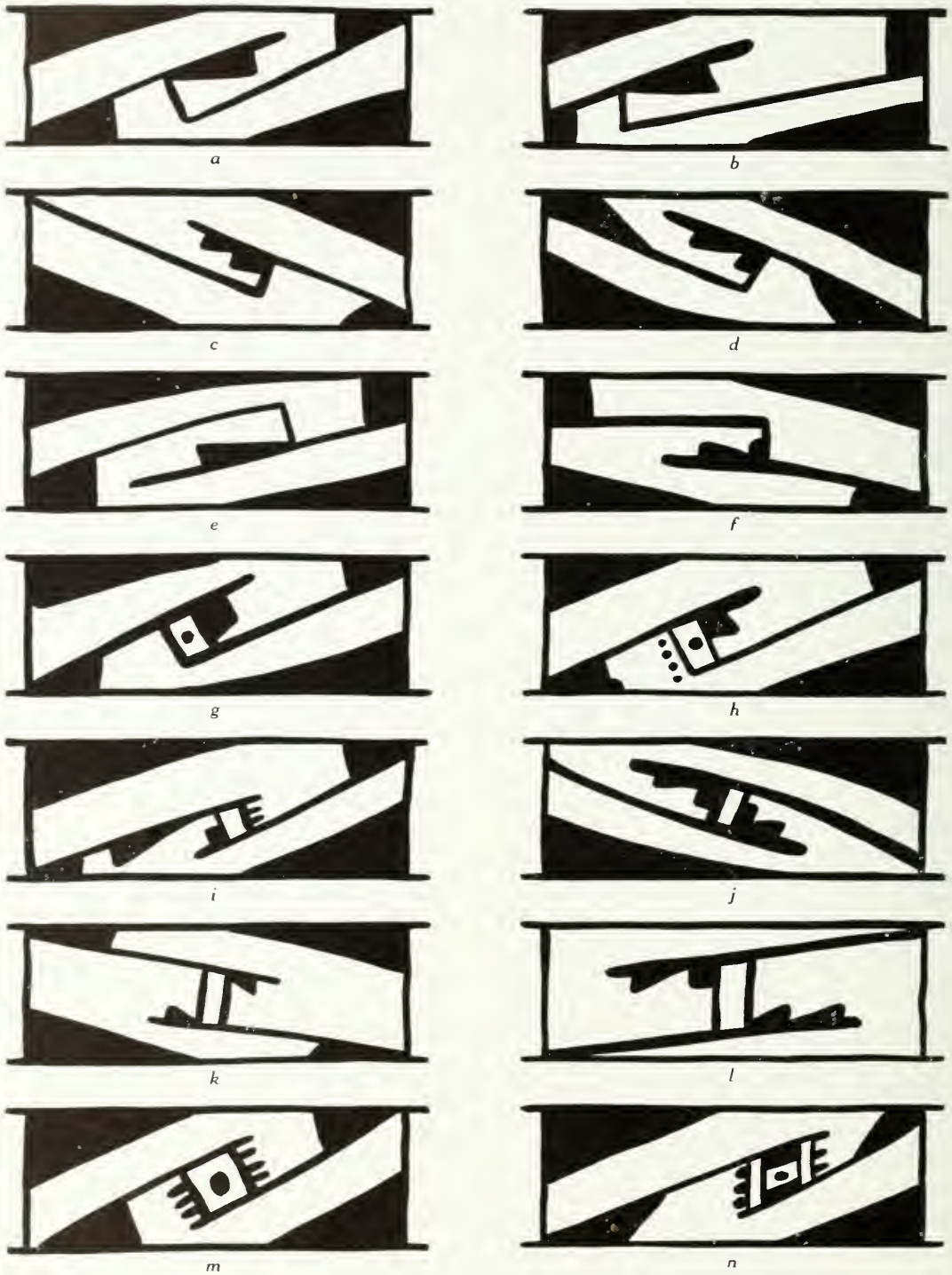


Fig. 114. Glaze III. Panels with slung single key (*a-i*); slung double key (*j-l*); slung rectangle (*m*, *n*).

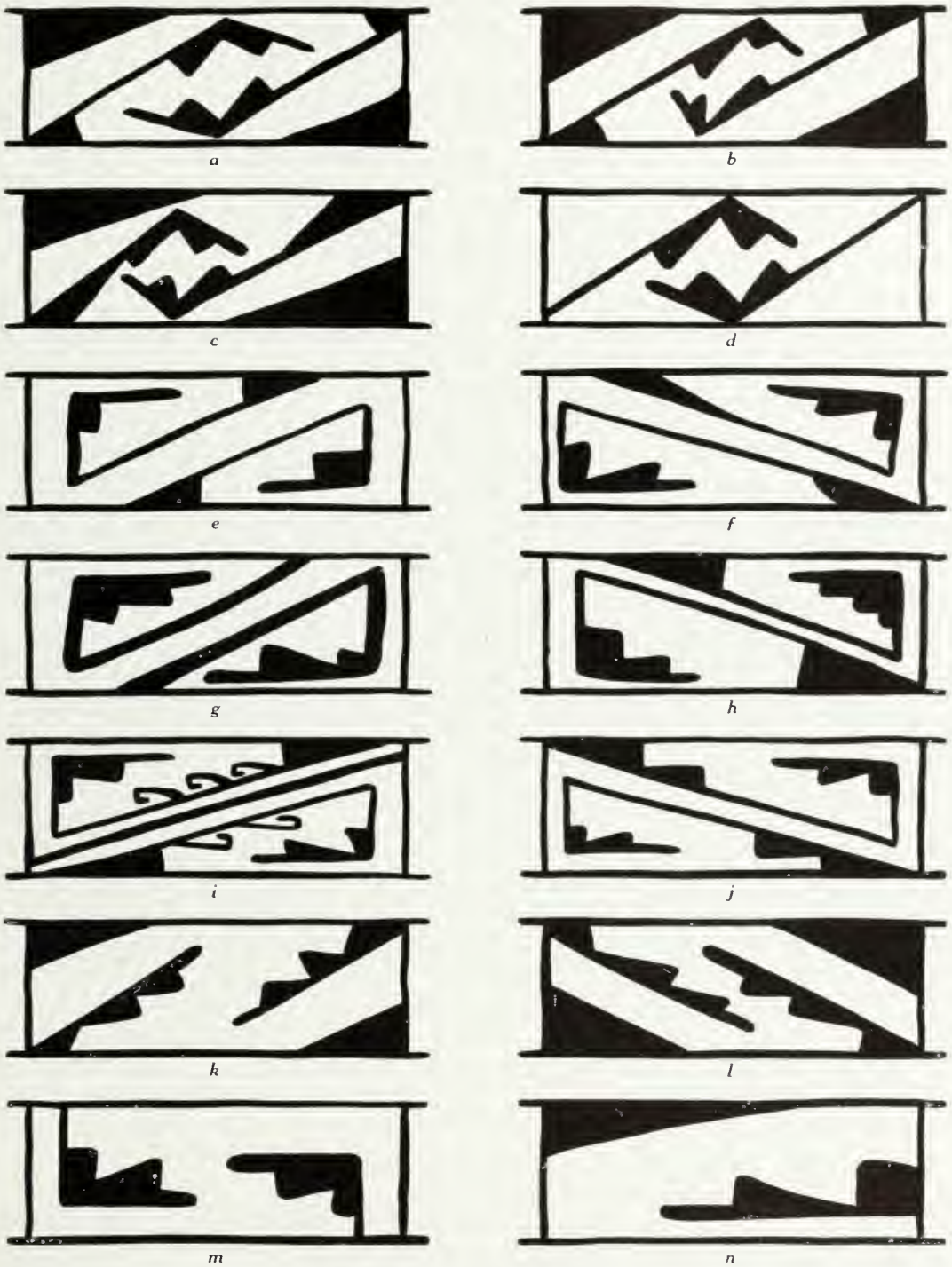


Fig. 115. Glaze III. Panels with key figures. *a-d:* Stalked key with base, directly opposed type. *e-j:* Indirectly opposed type. *k*, *l:* Unstalked oblique keys. *m*, *n:* Stalked keys without base.

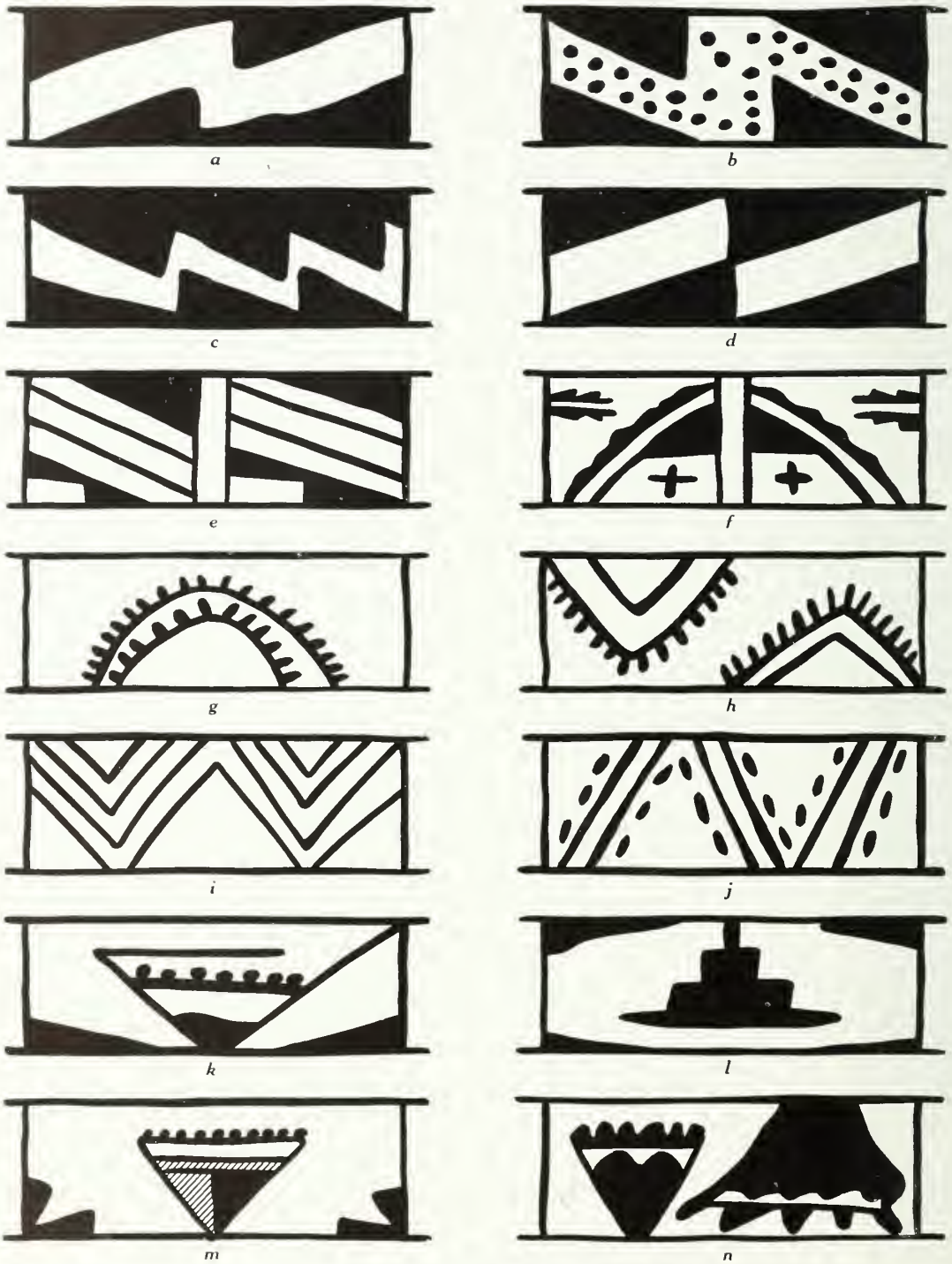


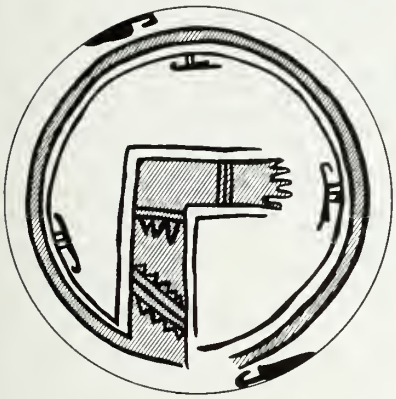
Fig. 116. Glaze III. Unusual or aberrant panels.

a

b

c

d



e

f

Fig. 117. Glaze III. All-over patterns from bowl interiors. At *a* appears the only use of lunes observed in the Glaze III material; the all-over effect is produced by the insertion of a double-bird figure. *b:* Apparently unique arrangement. *c*, *d*, *e:* Hand (?) patterns. *f:* Figure thought to be a prototype of the Glaze IV and V interior *capitans* (cf. fig. 153). For exterior decoration of *b*, see fig. 123, *e;* of *c*, fig. 123, *f;* of *d*, fig. 130, *d*. The exteriors of *a*, *e*, *f* are not reproduced. (1/8-1/6)

Zigzag (figs. 111, *f*; 116, *i*, *j*). The use of zigzags in panels appears for the first time in Glaze III. Although it is rare (five examples), it has been included with the more usual treatments rather than among the aberrants because it becomes of considerable importance in Glaze IV. Sets of two, three, or four parallel lines produce the zigzags. The lines may be plain (fig. 116, *i*) or dotted (*j*).

Aberrant panel layouts. The utilization of the panel as a field for the reception of one or two, more or less free-standing, figures, which occupy the field as a picture does a frame, was not observed in Glaze I or II. This practice begins sparingly to appear in Glaze III, but it does not become really frequent until Glaze IV. The figures so framed in Glaze III are birds (fig. 109, *b*, *c*, *d*), triangles (fig. 116, *g*, *h*, *m*, *n*) or terraced elements (fig. 116, *l*). They are attached to the banding lines, rather than to the ends or corners of the panels.

Other treatments so rare as properly to be classified as aberrant are: the simple X (fig. 113, *m*), and vertical subdivision into two smaller panels (fig. 116, *e*, *f*).

ALL-OVER PATTERNS

The use of the entire inner surface of a bowl as a decorative field was most unusual in Glaze I and II. This method is, on the other hand, extremely common in Glaze IV. Glaze III occupies, as might be expected, an intermediate position; less so in the actual number of all-over patterns which occur, for there are but six among the ninety-five whole pieces collected, than in the transitional appearance of those specimens, of which one obviously reflects earlier tendencies, while four are executed in the Glaze IV manner.

The patently atavistic example (fig. 117, *a*) should perhaps not be included among the all-overs, because its structure is really that of the Glaze I lune pattern which, it will be remembered, did not occupy the whole inner surface of the bowl. The lunes in the present case, however, are so broad as to leave very little space between them; and that area is occupied by a large red double-bird figure.

The four patterns which foreshadow later decorative practice are illustrated in fig. 117, *c-f*. Bold red figures running inward from the periphery are characteristic of Glaze IV. In the present Glaze III specimens the red figures of *c*, *d* and *e* presumably represent the human arm and hand, for in two cases they terminate in five finger-like projections (the greater number in *d* may perhaps be attributed to careless drawing); and on the five-fingered arms are what would seem to be bracelets. Enrichment of figures by the drawing of minor glaze elements, particularly small crosses, over the matte red pigment is another feature typical of Glaze IV (see figs. 152, 153 below), as is the use of birds (fig. 117, *e*) upon the encircling red stripe (cf. figs. 152, 153). The fourth bowl (fig. 117, *f*) bears a figure with three long projections, which should doubtless be considered a prototype of the Glaze IV interior *capitans* (see p. 177 and fig. 153 below). Oddly enough the red, which fills all later *capitans*, is here omitted. The band encircling the central figure is also a feature seldom observed in Glaze IV all-over treatments (but see fig. 154, *h*). The sixth all-over pattern (fig. 117, *b*) is apparently unique. The red paint is inferior, having flaked or worn almost completely away.

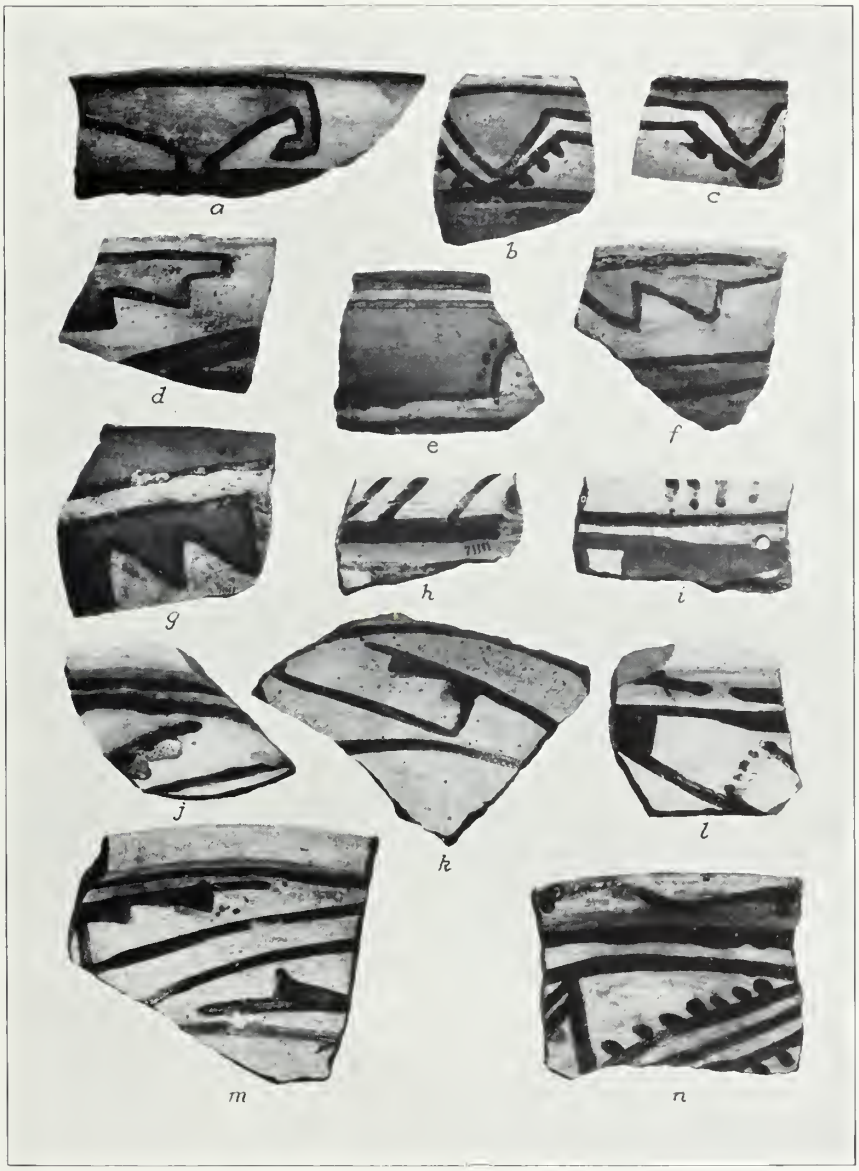


Fig. 118. Glaze III. Bowl sherds. *a-g:* Exteriors. *h-n:* Interiors. Sherds *e* and *g* are slipped red, their decoration is in glaze-bordered white. Width of *n*, $3\frac{7}{8}$ inches)

ELEMENTS OF BOWL INTERIOR DECORATION

Lines (fig. 118). Glaze III brushwork is about on a par with that of Glaze II, but the generally higher luster of the glaze paint gives a spurious effect of superiority. Lines are very much heavier and more irregular than in Glaze I; and, although little thicker than in Glaze IV, are drawn with a hand distinctly less sure. The average width of the Glaze III line is $^{3}/_{16}$ of an inch; this very approximate standard is maintained throughout the collection. Examples up to $^{5}/_{16}$ of an inch occur, as well as lines as narrow as $^{1}/_{8}$ of an inch. There is seldom, however, any tremendous variation on a given vessel, all the lines on a bowl or olla being of about the same intended width. I say intended advisedly, for the decorator was not often able to produce a long line which did not widen or narrow at some point. This is naturally most noticeable in the framer, which stands free and the effect of whose irregularities is therefore not minimized by the abutment upon it of other lines at close intervals. The framer seems, in some instances, to have been drawn with a single trailing stroke,[1] but quite as often the brush had to be dipped once, or twice, or several times, as is indicated by thickening of the paint or imperfect junctions. On one 11-inch bowl there can be discerned no less than twelve brush-marks. In this case, as shown by the overlaps of thick on thin glaze, the line grew counter-clockwise; in others the work proceeded clockwise; there seems to have been no special preference for either method.

Running of the glaze upon vitrification cannot often be blamed for the rather sloppy character of the patterns. Handsome general effect rather than precision of detail was evidently the criterion of successful decoration, for the lines are not only uneven in width, but are stragglingly drawn and carelessly spaced.

The line is primarily structural; seldom is it used as a purely decorative device. Hatching and crosshatching, for example, do not occur. Groups of short, close-set parallel lines sometimes serve to divide panels (figs. 109, *c*, *g*; 110, *d*, etc.); lines, plain or dotted, compose the rare zigzag panel fillers (fig. 109, *e-g*). The stepped line is absent.

Dots and Ticks appear infrequently as parts of band decorations. Dots are most often employed to embellish the outer edges of sets of lines, as in the above-mentioned zigzags; they are seen in the rare dotted checkerboard strips (fig. 112, *a*, *b*, *d*); even more rarely as space-fillers (*c*, *f*). Ticks fringe certain triangular figures (figs. 105, *c*; 110, *d*) and the short sides of the slung rectangle (fig. 114, *m*, *n*).

Checkerboard strips constitute the only use of checkerboarding (fig. 112, *a*, *d*). The reserved spaces are normally dotted. The "dotted eye," occasionally used in Glaze I to lighten and relieve a large black area, has not been noted.

Crosses. Two short lines transecting each other at right angles to form small simple crosses are seen fairly frequently in Glaze III decoration. They become even commoner in Glaze IV. An example appears in fig. 113, *m*.

Key figures. This ubiquitous device plays an important role in the interior decoration of Glaze III bowls. The forms in which it appears may be classified:

[1] Miss Shepard's experiments with glaze paints convince her that no line as long as an encircling framer could be drawn without dipping the brush.

Stalked key with base, directly opposed type
Stalked key with base, indirectly opposed type
Stalked key without base
Unstalked oblique key
Slung key
Slung double key

Stalked key with base, directly opposed type (fig. 115, *a-d*). This figure is used in pairs as a panel filler, the stalks coming from diagonally opposite corners. The faces are set closely together. The key is of very characteristic shape, with long terminal point and two steps, one of which runs backward along the stalk. There is a small triangular base. Differences between the present form and the analogous key of Glaze I are: obtuse rather than generally right-angled head; two steps with more or less obtuse angles, instead of three to five approximately right-angled steps; much smaller base (cf. figs. 115, *a;* 16, *a*).

Stalked key with base, indirectly opposed type (fig. 115, *e-j*). Also drawn paired in panels, the stalks of these keys often start from the banding lines near the corners, instead of emanating from the corners. The stalks are also longer. They run almost to the diagonally opposite corners, where they turn vertically upward and downward and terminate in keys which occupy the two other corners of the panel. The keys are opposed in that they face each other, but they are separated by the two parallel stalks. The key itself usually has two steps of somewhat variable proportions; the peculiar backward-running second step of the directly opposed keys does not seem to occur in this type. The base is again small (omitted in fig. 115, *g*). The stalks of one pair are ornamented with birdlets (fig. 115, *i*), in another with a step near the base (fig. 115, *j*).

Stalked key without base (fig. 115, *m*). As in Glaze I and II, this is rare. The large two-stepped keys are set on short stalks, which rise from the upper and lower banding lines respectively.

Unstalked oblique key (fig. 115, *k, l*). Paired in panels, from whose diagonally opposite corners they face each other. They are clumsier and less well drawn than the similar keys of Glaze I.

Slung key (fig. 114, *a-i*). This does not differ, in general structure, from the slung key of Glaze II (cf. fig. 81, *e-h*). It is, however, much more frequently used. In addition to simple one- and two-stepped examples (fig. 114, *a-f*) there are more elaborate forms with a small rectangular space behind the key; the space is usually ornamented with a single dot (fig. 114, *g, h*); in one case it is ticked in the slung rectangle manner (*i*).

Slung double key (fig. 114, *j-l*). This is a much better balanced and more pleasing figure than the single slung key. But, queerly enough, it is considerably less common. The two keys, one- or two-stepped with relatively short termination, are separated from each other by a small, ordinarily unadorned rectangular space (one sherd has a vertical row of four dots in the rectangle).

Slung rectangle (fig. 114, *m, n*). The central dot and the ticks which fringe

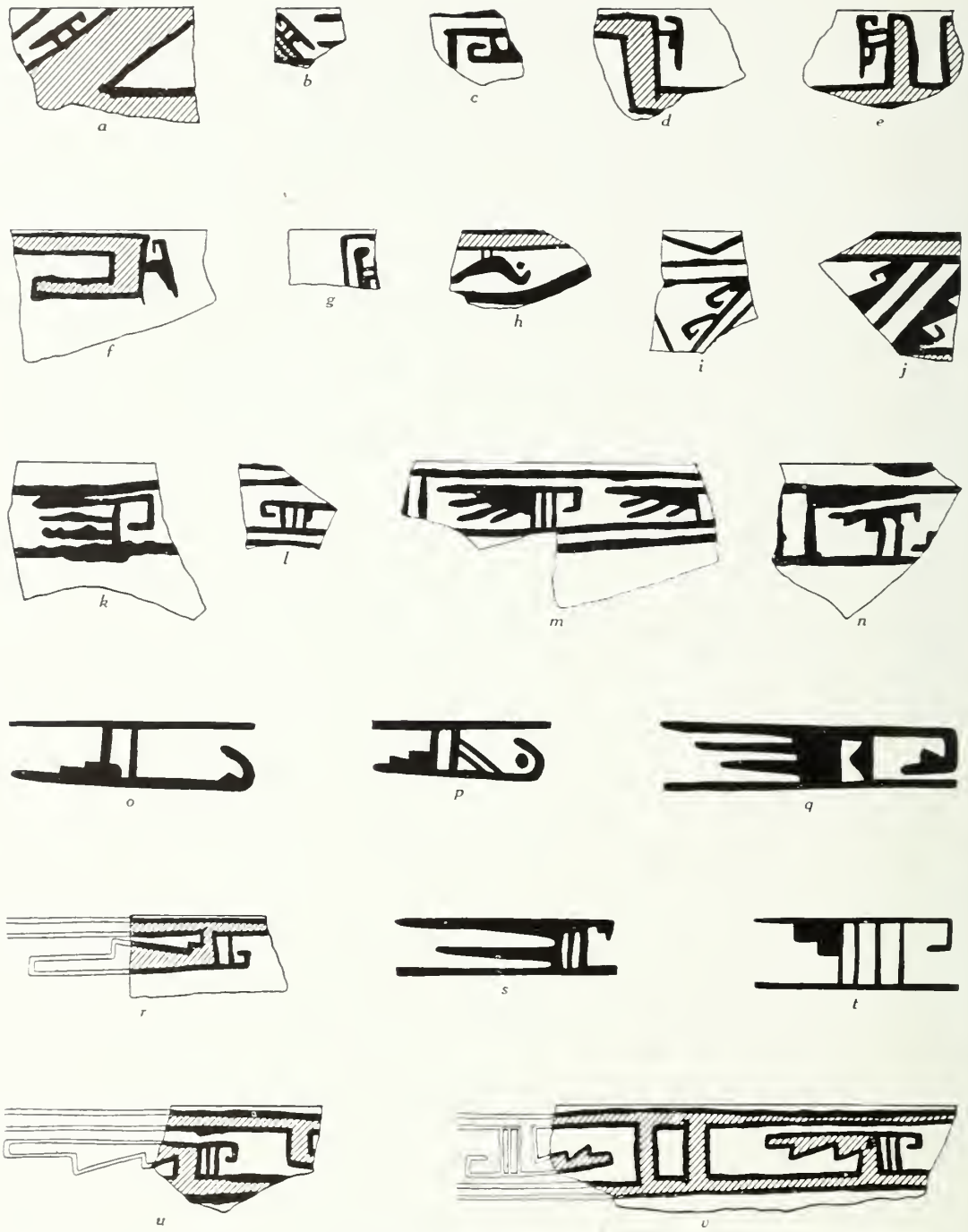


Fig. 119. Glaze III. Bird figures from bowls. *a-g:* Accessory birds, commonly found in Glaze IV, make their first appearance on the exteriors of Glaze III bowls. *h:* Unique form; exterior. *i, j:* Birdlets; interior. *k-q, s, t:* Pajaritan birds; interior. *r, u, v:* Key figures with heads and vertical members in the Pajaritan manner; exterior. (1/4)

two sides of the more or less square central element are features held over from the earlier Glaze types.

Slung bird (fig. 113, *g-j*).[1] This figure is so named because, like the slung key and slung rectangle, it is supported or attached by lines to diagonally opposite corners of the panel. The body is a solid black triangle lying between and connecting the usually obliquely running stalks; the head is a short crook at the end of one of the stalks. The figures are often rendered more realistic by adding, behind the body and upon the stalk which bears the head, a little triangular protuberance to suggest a tail-feather (fig. 113, *g*, *i*). Another sort of tail depiction consists of ticks at the rear of the body (*j*).

Slung double bird (fig. 113, *a-f*). This is a more common arrangement than the single bird. The end of each of the two stalks is provided with a curvilinear crook head. The two triangular bodies normally meet apex-to-apex in hourglass fashion. The tails are again sometimes elaborated by triangles; what may be meant for legs appear as two ticks on the lower rear part of the body in one example (*c*); there is a dot-eye in each of the crooked heads of another (*f*). Apparently reinforcing or emphasizing the bird symbolism of certain panels with slung double birds are birdlets upon the filled corners of the panels (*c*) or on the stalks (*f*).

Birdlet (figs. 113, *k;* 119, *i*, *j*). This small decorative device appeared rarely in Glazes I and II. In Glaze III it is somewhat commoner, coming into high favor in Glazes IV and V. In Glaze III it is mounted, as far as I am aware, only on oblique lines or on oblique edges of filled areas, usually upon sets of lines running diagonally across panels. It is a very simple figure, a triangle or even a mere line with a curvilinear or, more commonly, a right-angled crook head. A single pair may appear in a panel (as in fig. 113, *k;* and on the filled corners of *c*). As a rule, however, they are drawn in balanced, sequent series upon the lines, one series running up, the other down (see figs. 115, *i;* 119, *i*, *j*). They are particularly characteristic of the Glaze III-IV pottery of Puyé and Tuyonyi.[2]

Pajaritan bird (fig. 119, *k-q*, *s*, *t*). All bird figures so far considered, both in Glaze III and in the earlier Glazes, have had more or less triangular bodies; legs were either omitted or were naturalistically drawn. The type about to be described, which makes its first appearance at Pecos in Glaze III, differs from the above in that the body is replaced by a set of vertical lines across the top of which is a horizontal line, one end terminating in a usually right-angled crook-head, the other end forming the uppermost member of the tail. The accompanying drawing (fig. 120) shows the simplest form. Birds of this general type vary enormously, particularly in the construction and elaboration of the tail. In Glaze III they are not common. They appear as single figures in panels, alternating with some other device (fig. 109, *b*, *c*, *d*).

Miscellaneous birds. The last gasp, so to speak, of the birds which, in Glaze I and II, were perched upon the apexes of large pendant triangles (see figs. 20, 48) is seen in figure 110, *f*. The design is also one of pendent triangles, though there

[1] The large red birds, outlined with glaze, which, in Glaze III, are so often seen on the exterior of bowls and the necks of ollas, are described above.

[2] See Kidder, 1915, p. 438, pl. XXIII, 14-24.

are six small ones, rather than the two or three large units characteristic of the earlier types. But upon the apex of each of two of these triangles is set a tiny bird, thus preserving the old dual arrangement.

Repetitive series of small figures which may be identified as birds because of their terminal crooks are seen in figures 110, *a* and 113, *n*. The single figure at the junction of the crossed lines in figure 113, *m* is more obviously a bird.

A unique naturalistic bird occupies one panel of an otherwise very crudely drawn band pattern (figs. 110, *b*; 113, *l*). No vessel or sherd in the collection bears anything comparable to it. Lastly, the very aberrant band pattern shown in figure 110, *c* contains two interesting designs which seem to represent ducks upon the water. It may or may not be drawing too much upon one's imagination to believe that a shower of rain is about to fall upon the left-hand flock.

Fig. 120. Glazes III-IV. The Pajaritan bird. The essential features are: vertical body or leg members, rectangular crook head, horizontal tail whose uppermost member continues line of top of head. (1/2)

Uncommon or unique figures. The peculiarly bent line in figure 116, *k*, with its angle filled in and parallelled by a dotted line, represents the earliest appearance at Pecos of a figure found occasionally in Glaze IV (cf. fig. 150, *j*). Triangles, standing upon their corners, the opposite sides dotted, occur on two different bowls (fig. 116, *m*, *n*). There are also ticked triangles (*g*, *h*) which suggest the red "sunburst" designs of bowl exteriors (cf. fig. 131). The double terrace pendent from the upper banding line of a panel (fig. 116, *l*) is unique.

BOWL RIM DECORATION

Embellishment of the inner surface of the rim appears upon slightly more than half of the whole Glaze III bowls. Study of the sherd collection indicates that approximately the same percentage holds throughout the type. *Short lines* or *ticks*, vertical or oblique, constitute the commonest form of ornament; they may be continuous (fig. 103, *b*) or, more often, grouped in three or four sets of three or more (figs. 103, *g*; 105, *c*, etc.). These marks reach the edge of the bowl and sometimes lap over a little onto the lip. Dotting of the lip itself, which is so often seen in Biscuit A and B, occurs but once in the entire collection of bowls and sherds (fig. 70, *d*).

Next to ticks, in point of numbers, come small *bird figures*, two, three, or four of which are placed at more or less equal distances apart upon the rims of the bowls

(fig. 121). With few exceptions they face to the left. Although far from naturalistic, their triangular bodies and crooked heads, some of which bear the eye-dot, render it certain that they actually were meant to represent birds.

Zigzags are of nearly the same frequency as birds. A continuous line encircles the inner surface of the rim, usually taking the form of an oblique zigzag (fig. 107, *b*); less often the zigzag is vertical-oblique (fig. 104, *d*); most commonly of all, a softening or rounding of the lower angles gives the line a festooned effect (fig. 103, *a*). In all cases the upper points reach the edge of the lip; the lower points (or curves, if the line be a festoon) normally do not touch the band's upper framer.

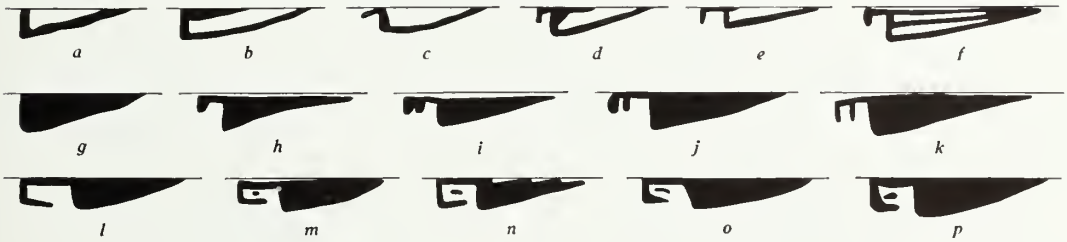


Fig. 121. Glaze III. Small bird or bird-like decorations from interiors of bowl rims. The birds at *h* and *k* actually face to the right; they have been reversed to facilitate comparison with the others. Drawn from sherds. Other examples will be found in figs. 104 to 110. (2/7)

The rarest rim decoration consists of *small triangles*, either made by a bent line (fig. 121, *a*) or solid (*g*). Like the birds, three or four such objects appear on the circumference of a bowl. In shape they are so similar to the bodies of birds that some connection between the two ornaments may be suspected, but whether the triangles are conventionalized birds, or whether (as seems more probable) the birds are "realized" triangles, cannot be decided on the basis of the material in hand.

No correlation can be established between any of the above varieties of rim decoration and any type of interior or exterior pattern.

BOWL EXTERIOR DECORATION

All Glaze III bowls bear exterior decoration. Every one of our whole pieces is so treated; and, among the thousands examined, there was encountered no sherd of any size which lacked this form of embellishment. The figures are normally in matte red pigment outlined with glaze. Ornamentation in glaze without red is rare (5 cases among 95 bowls); there is but one example (fig. 123, *d*) of the paired oblique dashes which appeared so commonly in Glaze I and II.

The red figures may be classified as follows:

Keys	43
Birds	19
Bands	16
Zigzags	8
Miscellaneous	7
	93

KEY FIGURES

Key figures in red are found, as the above tabulation shows, on the exterior of nearly half of all Glaze III bowls; they occur upon the necks of an even larger percentage of ollas. The typical form is double-ended, the two keys being brought into opposition by angular bendings of their common stalk. A closely similar device, it will be remembered, was commonly found in Glaze II. The Glaze III examples have the same two-stepped keys (one- and three-stepped keys appear in figs. 124, *d* and 123, *d* respectively), but they are, on the average, longer and more slender. The interlocking arrangement, in which two double-ended key figures are combined to produce a current pattern encircling the bowl, was not noted in Glaze II. The relative abundance of the different forms is expressed in the subjoined classification:

Double-ended keys	40
Free standing	23
Right-angled (fig. 122)	13
Oblique (fig. 123, *a-e*)	10
Interlocked (fig. 124, *a-e*)	11
On base-stripe, oblique (fig. 123, *f-h*)	6
Single keys on base-stripe (fig. 124, *g*, *h*)	3
	43

BIRD FIGURES

These large, handsome ornaments appear on the exterior of many Glaze III bowls. As a decorative device they were second in popularity only to the double-ended keys (see tabulation above). They apparently always rise from a red base-stripe, never being free-standing, as were some of the Glaze II birds. The bird with tripartite tail (fig. 90), the normal Glaze II form, has practically disappeared (one very degenerate example on an early Glaze III bowl—fig. 128, *a*). Detailed classification of the Glaze III figures is difficult, because of their great variability. There may be recognized, however, two general categories:

Birds red throughout
Birds with red forepart

BIRDS RED THROUGHOUT. The complete figure—body, head, and tail—is red, continuing the red of an encircling base-stripe, usually without exit space. The most naturalistic form, illustrated in figure 126, may be called the *bird with cocked-up tail*. It is rare (six certain examples, two doubtful). Unfortunately no whole vessel bears this sort of bird, nor was there recovered any sherd large enough to show an entire

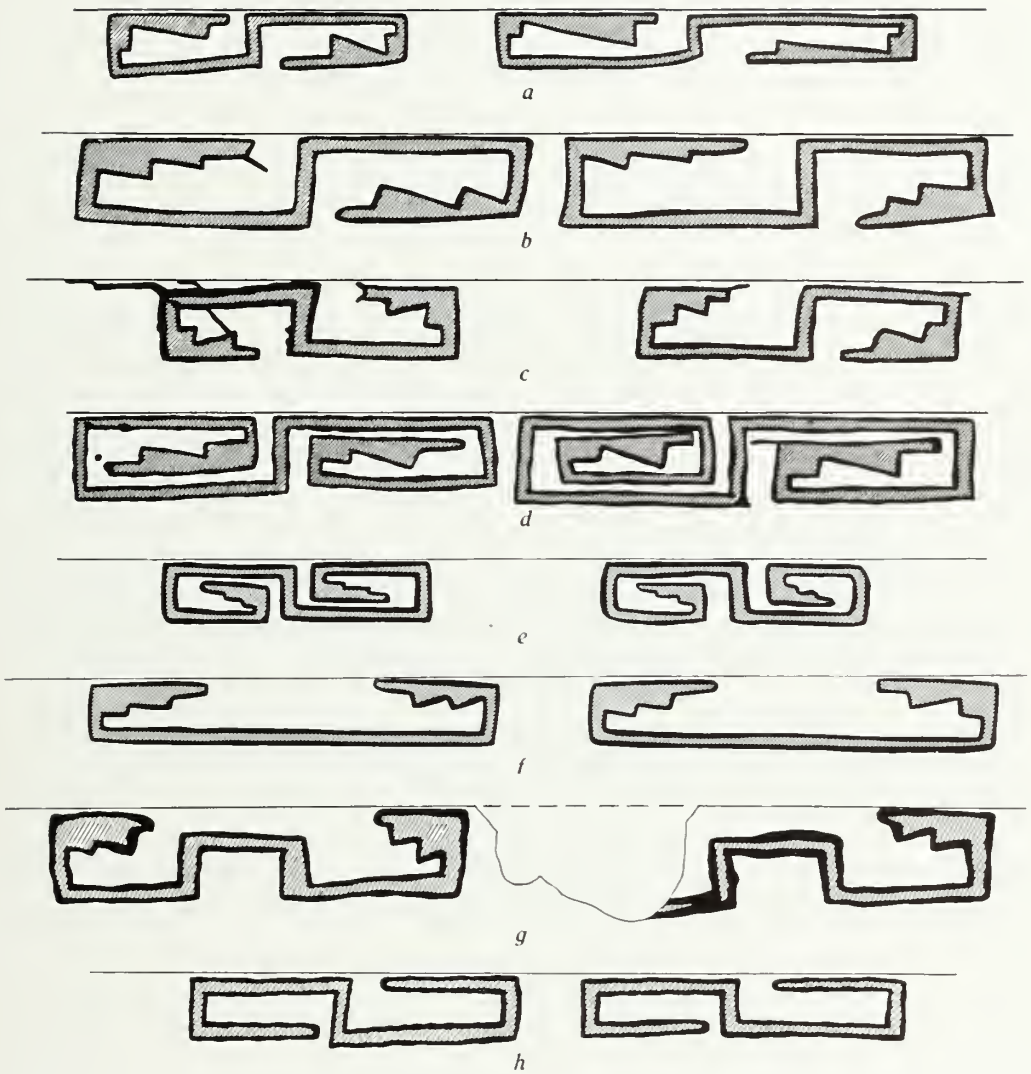


Fig. 122. Glaze III. Glaze-bordered red double key decorations from bowl exteriors, freestanding, right-angled type. The close resemblance to Glaze II forms (see fig. 88, *a-d*) should be noted. Glaze III keys, however, tend to be longer; and the involuted arrangement (*d*, *e*) has not been observed in Glaze II. The simple figure at *h* is unique. For interior decoration of *a*, see fig. 108, *d*; of *b*, fig. 106, *h*; of *c*, fig. 104, *e*; of *f*, fig. 104, *a*. The interiors of *d*, *e*, *g*, *h* are not reproduced. (1/8)

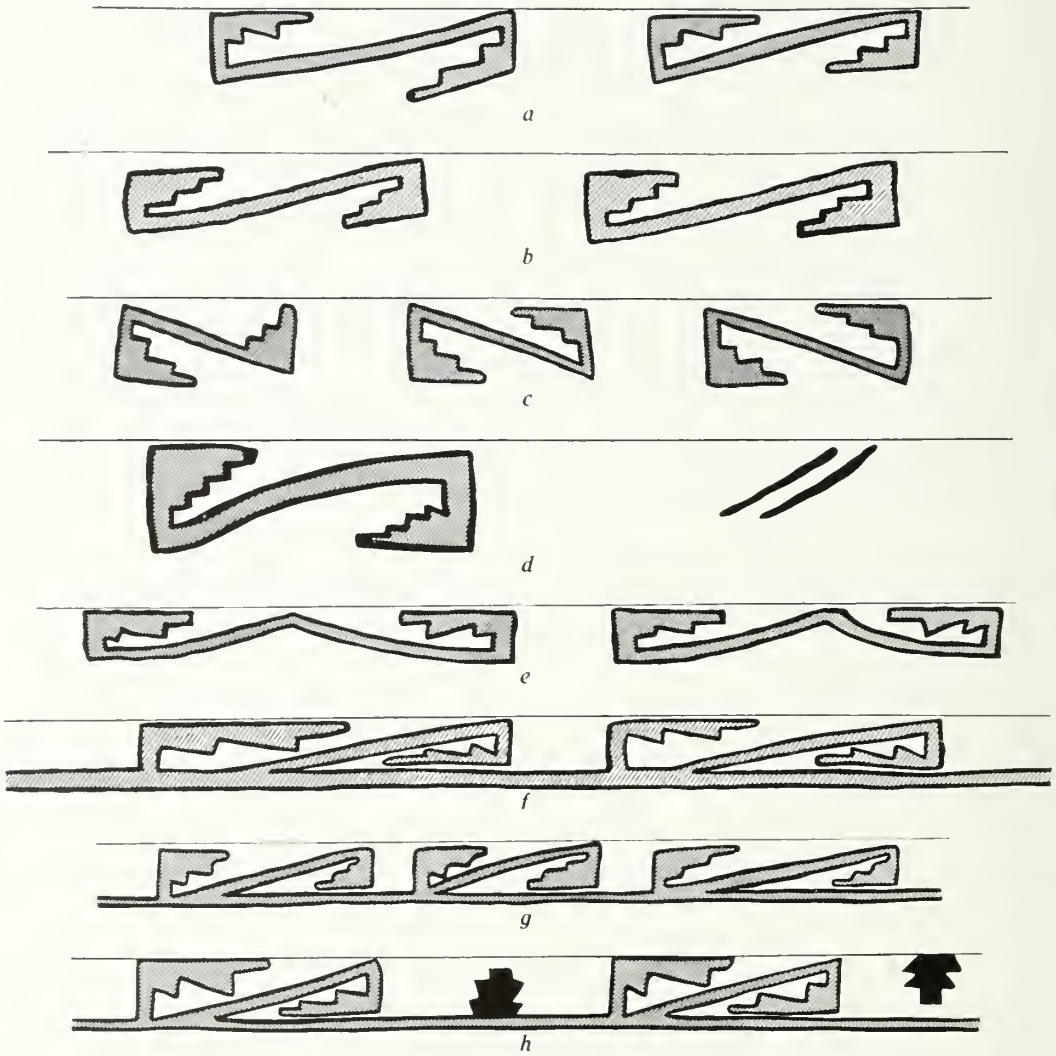


Fig. 123. Glaze III. Glaze-bordered red double key decorations from bowl exteriors, oblique type. *a-e:* Free-standing. *f-h:* On base-stripe. These are closely similar to Glaze II forms (cf. fig. 88, *e-g*). At *d* is seen the only example of the use on a Glaze III bowl of the paired dashes so abundant in Glaze I and so common in Glaze II. For interior decoration of *a*, see fig. 107, *c;* of *c*, fig. 105, *a;* of *e*, fig. 117, *b;* of *f*, fig. 117, *c;* of *g*, fig. 106, *a*. The interiors of *b*, *d*, *h* are not reproduced. (1/8)

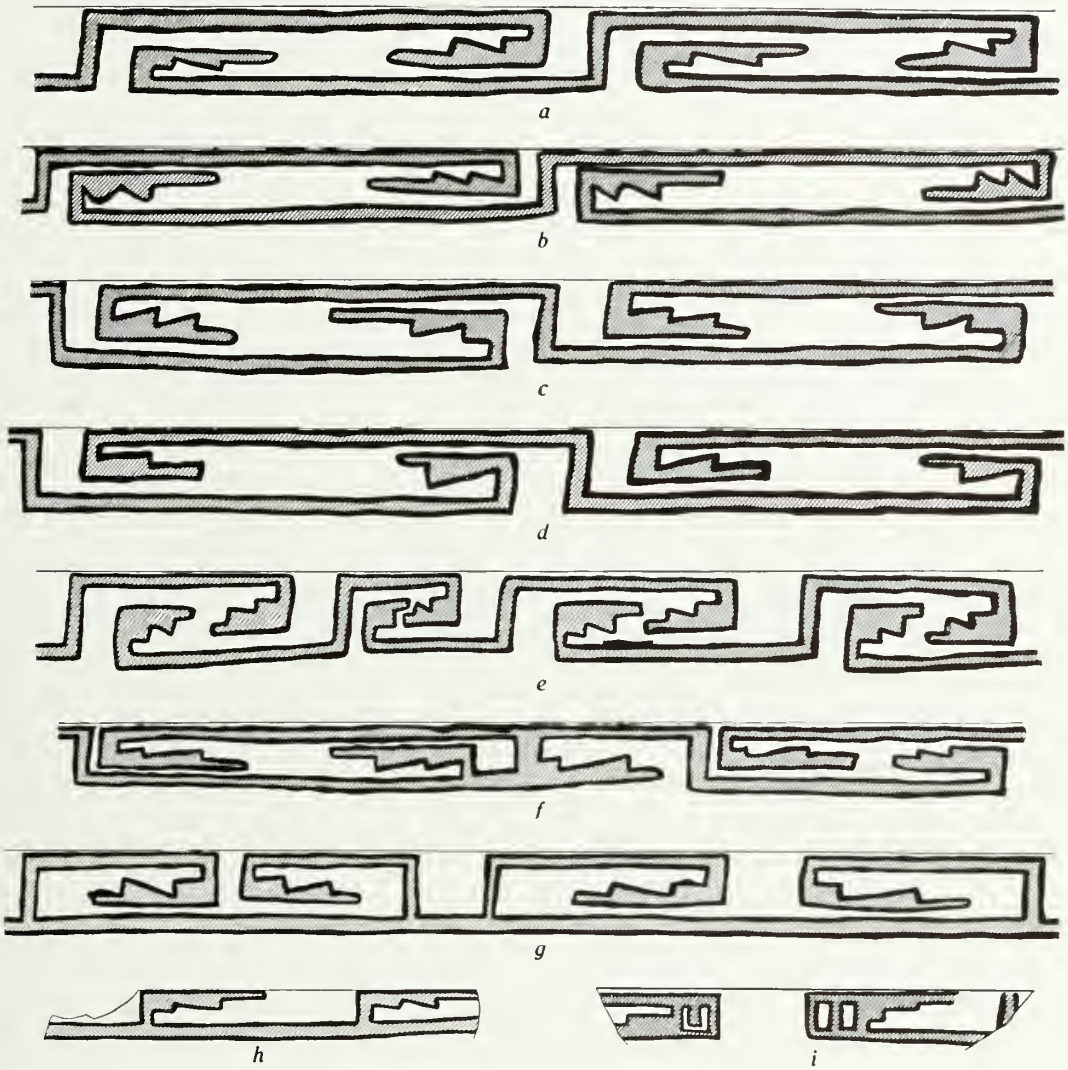


Fig. 124. Glaze III. Glaze-bordered red key decorations from bowl exteriors. *a-e:* Interlocking type of right-angled double key. *f:* Probable error by decorator, an extra key has been introduced. *g*, *h:* Single keys rising from base-line. *i:* Aberrant form. For interior decoration of *b*, see fig. 110, *f;* of *c*, fig. 110, *g;* of *d*, fig. 109, *b;* of *f*, fig. 106, *d;* of *g*, fig. 108, *e*. Interiors of *a*, *c*, *h*, *i* not reproduced. (1/8)

example. The fragmentary material indicates, however, that upon a short protuberance from the red base-stripe, perhaps representing legs (fig. 126, *a*), or directly upon the base-stripe (as would seem to be indicated in *e*) there was set a plump-breasted body. The head is round, with centrally placed dot-eye. The bill, in two cases at least, is realistic, both mandibles being shown (*e*, *f*). The tail is cocked perkily upward to the level of the top of the head. All examples face to the right. There is no way of telling how many birds were placed on each bowl. The sherds bearing these figures are all from small bowls (seemingly of 8- to 9-inch diameter) with unusually clear yellow-white slip. Their rims are of the straight-faced variety (fig. 97, *a-c*)

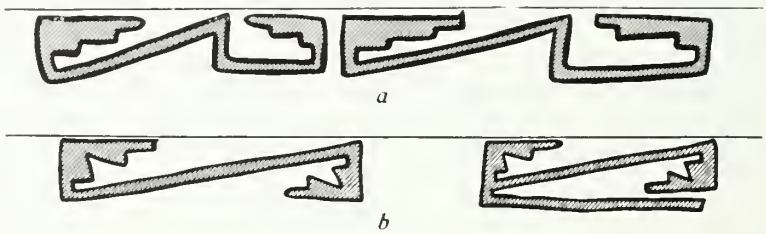


Fig. 125. Glaze III. Glaze-bordered red double key decorations from bowl exteriors, aberrant forms. *a:* Half oblique, half rectangular. *b:* Left figure normal, right with short section of base-stripe (cf. fig. 123, *f-h*). Interior patterns not reproduced. (1/8)

Fig. 126. Glaze III. Glaze-bordered red decorations from bowl exteriors. Bird with cocked-up tail. This semi-naturalistic rendering of the bird is restricted to the exteriors of Glaze III bowls and the necks of Glaze III ollas. From sherds. (1/8)

which occurs occasionally in Glaze II (fig. 68, *j*) and which is undoubtedly early in the Glaze III series.

Much more common are *birds with triangular body* (figs. 127, 128). They are also much less lifelike. One corner of the vaguely triangular body joins the base-stripe; from another comes the head; from the third extends the plain, straight tail. The top of the head, the back, and the tail form a single line parallel to, and close below, the lip of the bowl. The head varies considerably. In some cases it is a curvilinear crook (fig. 127, *a-c*); in some (and these examples are in other ways more severely geometrical) it is bent once (fig. 127, *g*, middle figure) or, much more commonly, twice at right angles to form a rectilinear crook (*e-h*). The eye is seldom represented (*d*). There are some rather more elaborate forms: open spaces may appear in the

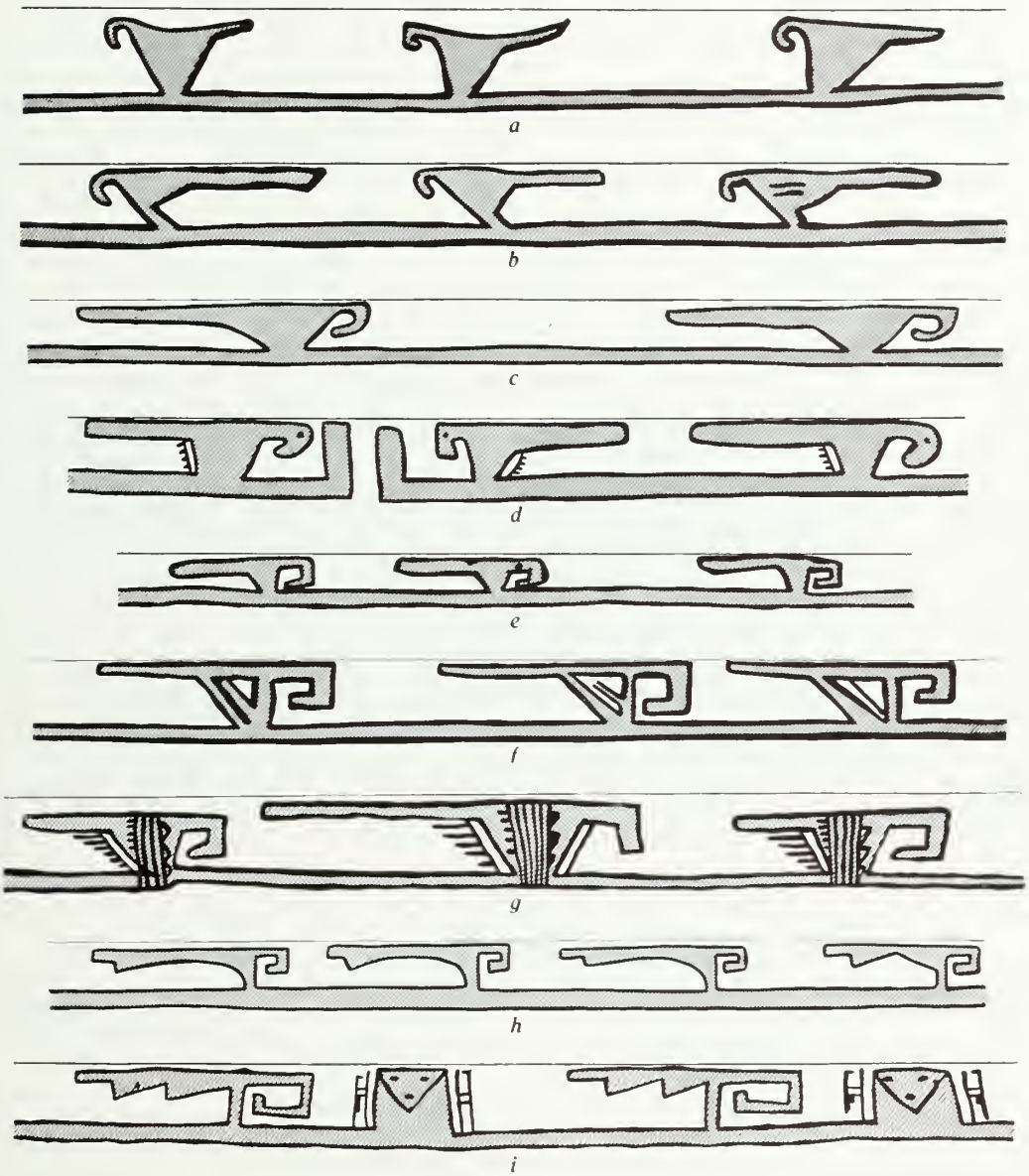


Fig. 127. Glaze III. Glaze-bordered red decorations from bowl exteriors. Birds red throughout. From bowl exteriors. For interior of *a*, see fig. 103, *g*; of *b*, fig. 104, *g*; of *c*, fig. 105, *g*; of *d*, fig. 109, *e*; of *f*, fig. 110, *c*; of *g*, fig. 110, *d*; of *h*, fig. 109, *c*; of *i*, fig. 106, *c*. Interior of *e* not reproduced. (1/8)

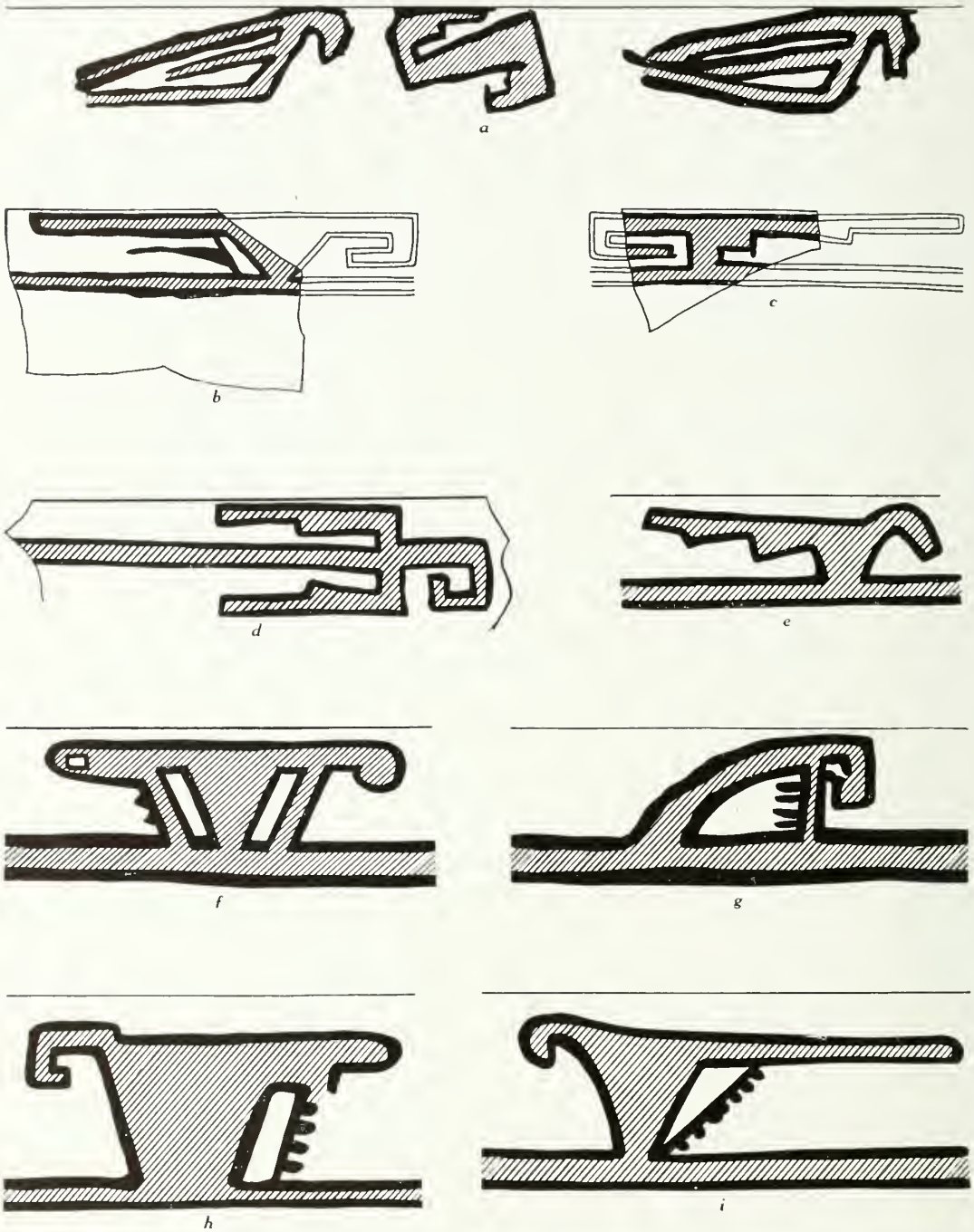


Fig. 128. Glaze-bordered red decorations from bowl exteriors. Birds red throughout and other forms. *a:* The only Glaze III example of the bird with tripartite tail. *b:* Triangular bodies. *c*, *e:* Terraced tail. *d:* Unique form with terraced, key-like wings (?). *f*, *h*, *i:* Triangular bodied. *g:* Aberrant form (cf. fig. 110, *a*). From sherds and fragmentary bowls; interior decorations not recoverable. (1/4)

body (*f*); there may be a short line paralleling the rear of the body ornamented with dots (figs. 127, *d*; 128, *h*, *i*), dashes (fig. 127, *g*), or small triangles (fig. 128, *f*). Three birds is the usual number per bowl; the figures may face either right or left, but those on any given specimen almost always face the same way (fig. 127, *d* is an exception).

Birds with terraced tail (figs. 127, *h*, *i*; 128, *c*) are uncommon. They are severely geometric. The body is a straight vertical bar, the head a rectilinear crook. The tail

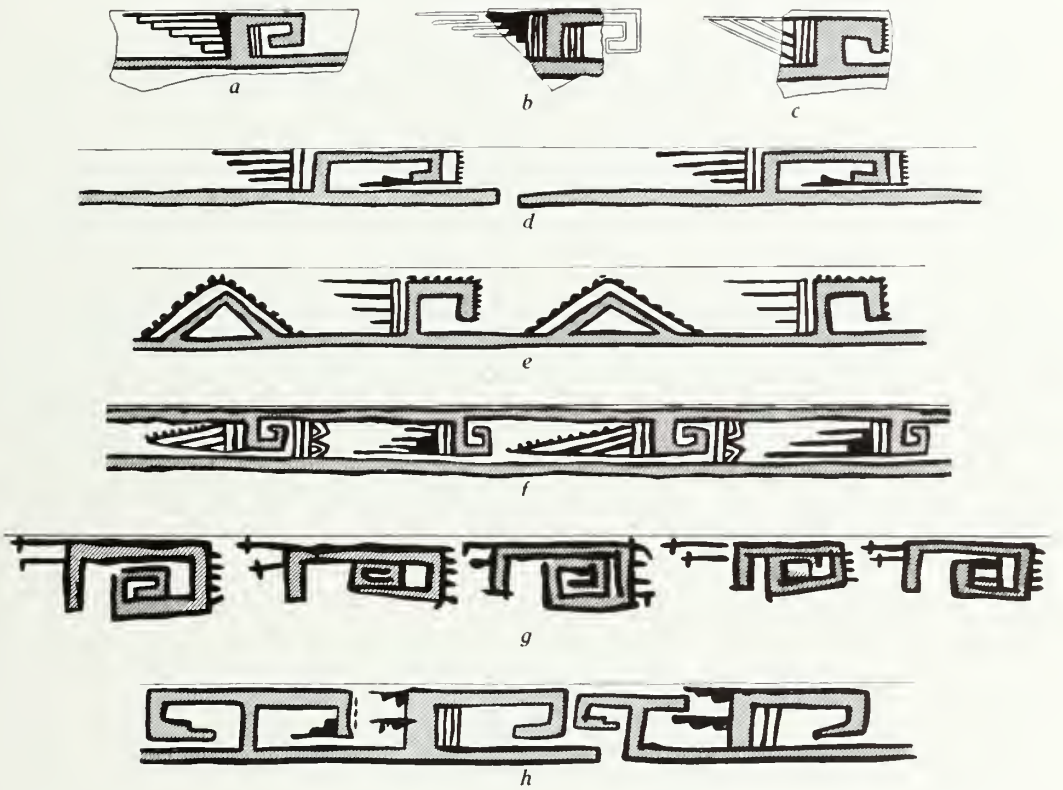


Fig. 129. Glaze III. Glaze-bordered red decorations from bowl exteriors. Birds with red forepart, a form rare in Glaze III, but common in Glaze IV (cf. fig. 163). The birds *a-c* are from sherds; patterns *d-h* from complete bowls. For interior design of *d*, see fig. 106, *g*; of *e*, fig. 108, *a*; of *f*, fig. 107, *a*; of *g*, fig. 109, *f*; of *h*, fig. 109, *a*. (1/8)

is a two- or three-terraced projection, a slightly elongated copy, in most cases, of the red key figure so abundant on Glaze III bowl exteriors. An interesting variant of the bird with terraced tail appears in fig. 119, *r*, *u*, *v*. Vertical lines and rectangular crook heads are applied to ordinary red keys, thus transforming them into a sort of cross between the Pajaritan and terraced tail types.

Birds with red forepart (fig. 129) differ from examples of the much more common all-red birds in that the tail, instead of being a mere continuation of the

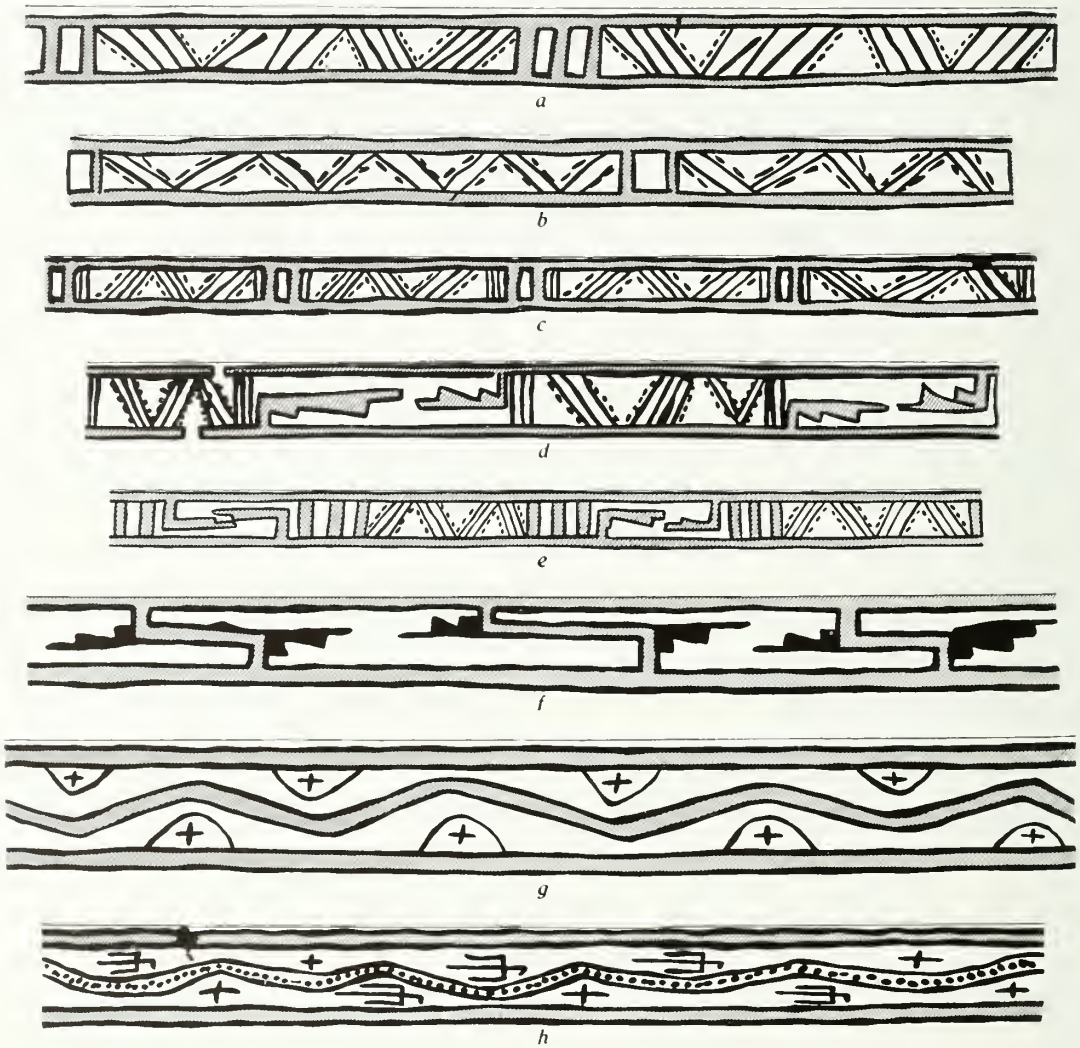


Fig. 130. Glaze III. Glaze-bordered red decorations from bowl exteriors. Paneled bands (*a-e*) and bands with zigzags (*g*, *h*); the band at *f* is of a rare, but not unique, type. For interior of *b*, see fig. 103, *c*; of *c*, fig. 109, *d*; of *d*, fig. 117, *d*; of *e*, fig. 107, *b*; of *f*, fig. 105, *d*; of *g*, fig. 108, *f*; of *h*, fig. 105, *c*. The interior of *a* is not reproduced. (1/8)

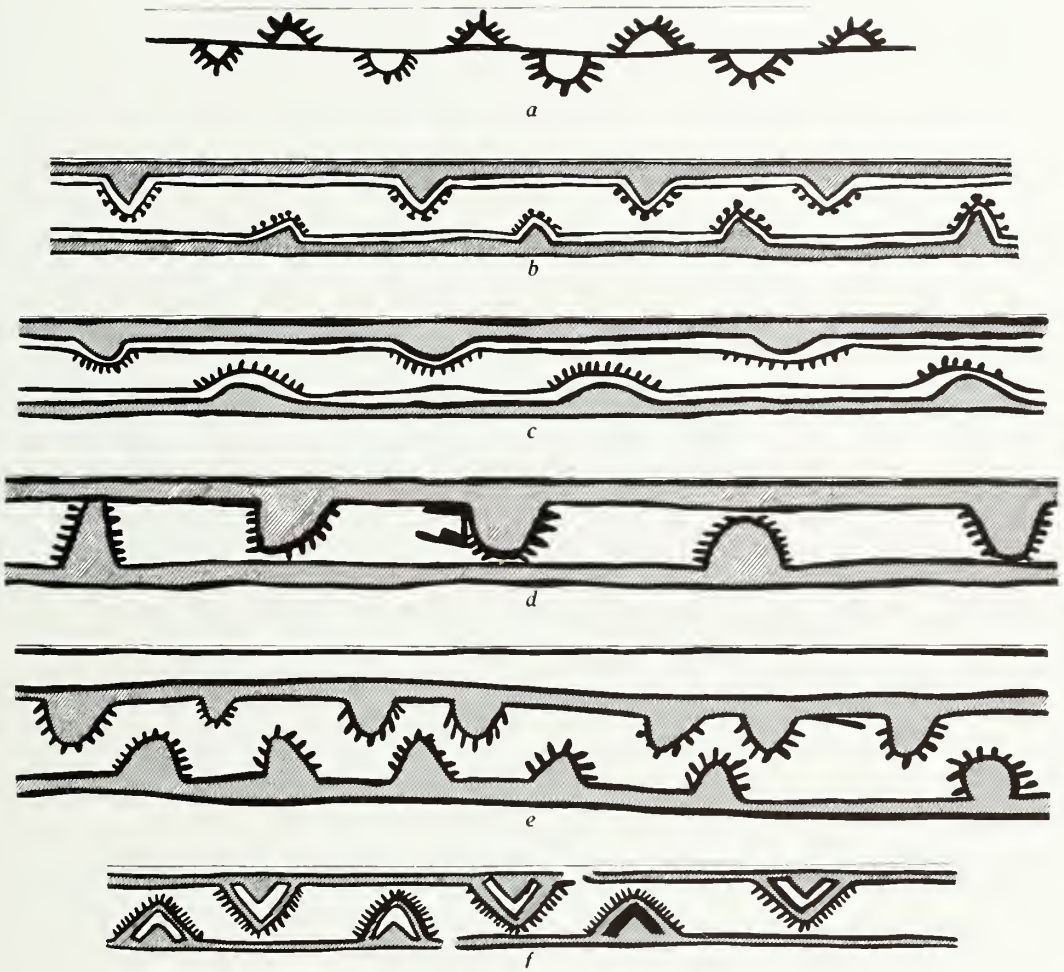


Fig. 131. Glaze III. Glaze-bordered red decorations from bowl exteriors. "Sunburst" bands, a catchword name for a pattern whose significance is unknown. The example at *a* is one of the few Glaze III exterior designs in glaze alone. *a:* From shouldered bowl, no interior decoration. For interior of *b*, see fig. 104, *f;* of *c*, fig. 108, *g;* of *d*, fig. 110, *e;* of *e*, fig. 103, *f;* of *f*, fig. 103, *e*. (1/8)

mass of the figure, is a more or less elaborate appendage done in glaze alone. The body (if a plain bar can so be dignified) rises vertically from the base-stripe, bends at right angles to form the neck and terminates in a rectilinear head. A set of lines usually parallels the vertical body. The tail is attached to these lines or, if they are absent, or if they are placed in front of the body, it is attached directly to the body. The topmost element of the tail continues the upper line of the head. It may consist of plain lines (fig. 129, *d*), of lines with terraced blocking between them (*b*), or of key figures (*h*). It may be right triangular, plain (*c*) or with dots along the hypothenuse (*f*). The head, in some cases (*d*, *e*, *g*), bears dots or ticks; this feature becomes conventional in the birds with red forepart of the later Glazes. The figures normally face to the right.

Accessory birds (fig. 119, *a-g*) are very small figures in the Pajaritan manner (i.e., with vertical members, rectangular crook heads and usually terraced tail), which are used to enrich larger, usually red, figures upon bowl exteriors and all-over interior patterns (fig. 117, *e*). They are rare in Glaze III, but become very common in Glaze IV.

BANDS

The framework, so to speak, of all exterior bands consists of two parallel red stripes, which may be called the banding stripes. In only two cases are they broken by exit spaces (figs. 130, *d*; 131, *f*). On the basis of the ornamentation of the space between the banding lines, the patterns may be classified as follows:

Paneled bands	7
Bands with zigzag	2
Sunburst bands	7
	16

Paneled bands (fig. 130, *a-e*) are subdivided, as a rule, by sets of two or three vertical red paneling bars (*a-c*, *e*). The resultant panels are occupied either by oblique zigzag lines with dots or by the same sort of zigzags alternating with paired red key figures (*d*, *e*). On the sherds these two arrangements occur again and again with very little variation. The band at *f*, subdivided by jogged red lines at whose two angles are key figures, although of a rare type, is not unique, as a fragment bears parts of an identical pattern.

Bands with zigzag (fig. 130, *g*, *h*). Between the two banding stripes, but not touching them, runs a zigzag, red in one case (*g*), dotted in the other (*h*). In the triangular spaces between the zigzag and the banding lines are small figures (crosses, peculiar little "spread-eagle" birds) in glaze. According to the sherds this pattern is rare.

Sunburst bands (fig. 131). Although this is one of the minor patterns, in point of frequency, it is, as the illustration shows, highly standardized. It is apparently confined to Glaze III. The designation which I have coined bears no implication as to what, if anything, was symbolized by these series of rounded or angular

protuberances from pairs of unbroken red banding-stripes. All the complete patterns found are reproduced in fig. 131. Among the sherds are many fragmentary examples, all of which run perfectly true to type. There is only one case of sunbursts without red (fig. 131, *a*).

Apparently closely allied to the sunburst is a non-band pattern consisting of a series of dot-edged red triangles arising from a red base-stripe (fig. 132). All of our six or seven examples are fragmentary.

ZIGZAG DECORATIONS

Red zigzags (fig. 133), although relatively uncommon (see tabulation, p. 142) are remarkably uniform. Study of the considerable number of sherds which bear parts of these patterns reveals practically no variation from the arrangements

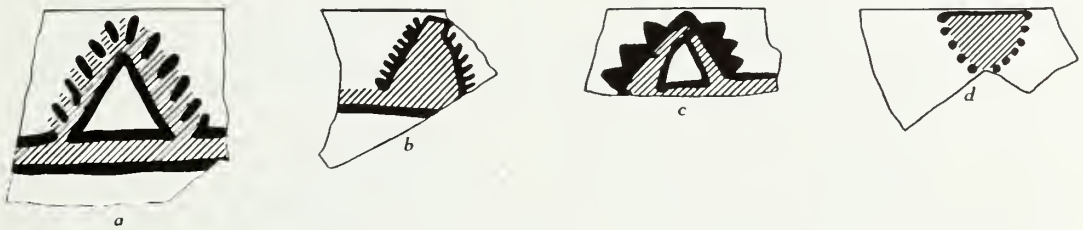


Fig. 132. Glaze III. Glaze-bordered red decorations from bowl exteriors. Fragments bearing figures allied to those appearing in the sunburst bands (cf. fig. 131). At *a* and *d* are two of the very few cases observed in which red pigment is outlined by dots or dashes rather than by glaze lines. (1/4)

shown in the drawing. They appear to be restricted to Glaze III and, within that type, to bowls and sherds of the most strongly marked sort (i.e., with definitely recurved rims) characteristic of the middle part of the Glaze III period. The zigzag is always of the vertical-oblique type. It may stand free (fig. 133, *a*), but more commonly it is set upon (*b*) or below (*c*) or closely adjacent to (*e*) a red stripe which encircles the vessel without exit space. Each of the triangular fields between the points of the zigzag and the bowl rim (*g*, *h*) or the red stripe (*e*, *f*) is usually occupied by a small, slender-stalked key figure with triangular base. These key figures are all much alike, generally with two angular steps and a long, delicate termination. The sherds show several examples of identical form and arrangement.

MISCELLANEOUS RED EXTERIOR DECORATIONS

As may be seen in figure 134, *c-h*, where are reproduced six miscellaneous red exterior decorations from whole bowls, the treatment is usually one of repeated units. Human hands seem to be represented by the two figures at *d* (cf. all-over interior patterns in fig. 117, *c-e*). The two notched-ended ornaments in figure 134, *e* enclose elongated fields, which are occupied by conventional panel-designs (the resemblance

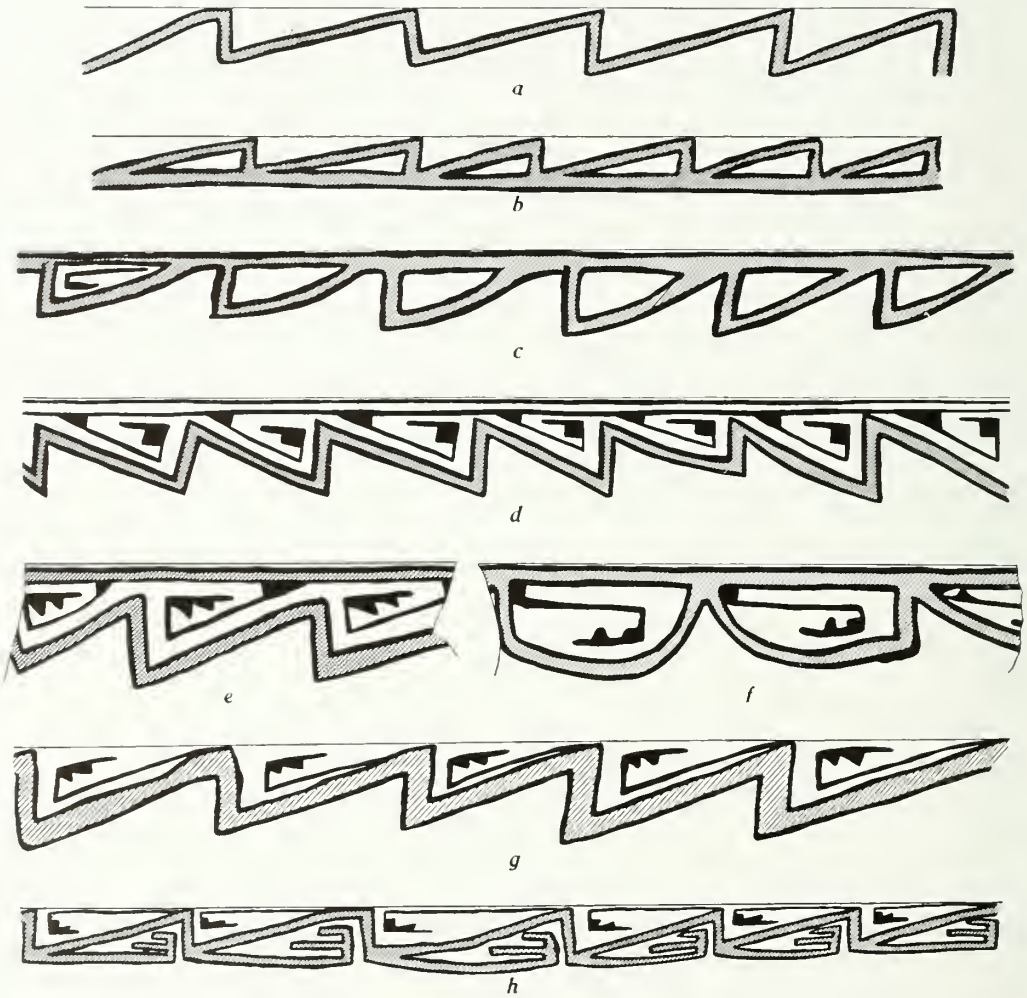


Fig. 133. Glaze III. Glaze-bordered red decorations from bowl exteriors. Zigzags. For interior decoration of *a*, see fig. 106, *f;* of *b*, fig. 103, *a;* of *d*, fig. 104, *d;* of *f*, fig. 104, *c;* of *g*, fig. 106, *e;* of *h*, fig. 110, *b*. The interiors of *c*, *e* are not reproduced. (1/8)

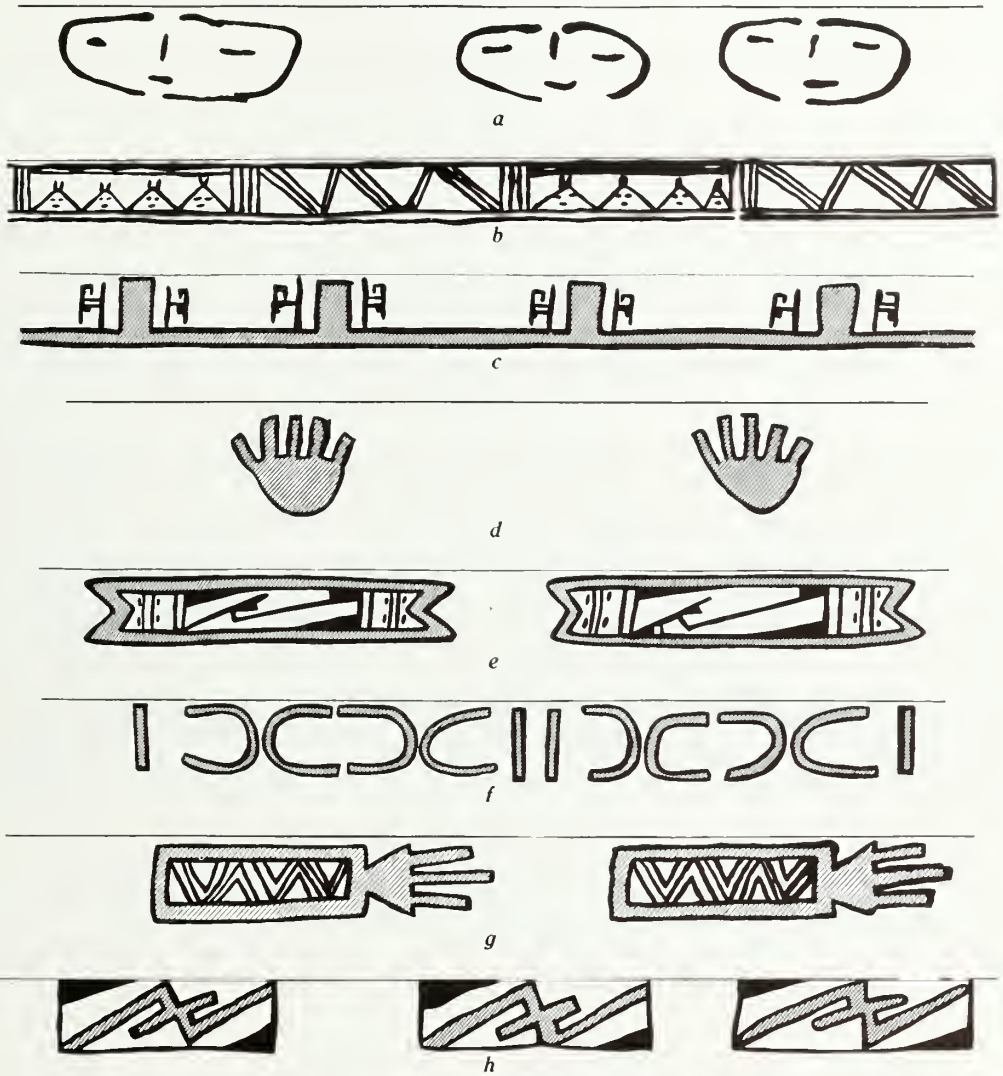


Fig. 134. Glaze III. Miscellaneous exterior decorations. At *a* and *b* are two of the rare patterns executed in glaze alone; *a* crudely depicts human faces, the little triangles of two of the panels in *b* may also be anthropomorphic. The pattern at *g* is the earliest example of the *capitan*, an abundant figure in Glaze V. For interior decoration of *a*, see fig. 105, *b*; of *b*, fig. 108, *c*; of *c*, fig. 104, *b*; of *d*, fig. 103, *b*; of *g*, fig. 108, *b*; of *h*, fig. 105, *f*. Interiors of *e*, *f* not reproduced. (1/8)

to *capitan* bodies is striking; cf. fig. 134, *g*). At *f* is a unique arrangement of bars and curved objects which, were Glaze III not certainly prehistoric, might be taken for the tracks of shod horses. The earliest occurrence of a figure which is relatively common in Glaze IV and abundant in Glaze V is recorded at *g*. It is a long rectangle, one end of which bears a triangular protuberance terminating in three projections. The present Glaze III example is very similar, in general structure, to those of the succeeding periods, but it lacks the eyes and mouth which give many Glaze IV and all Glaze V specimens the appearance of consciously anthropomorphic depictions. The *capitan*, as I have called this figure, is more fully discussed below (p. 177). Last among the repeated unit treatments is an effective triple arrangement (fig. 134, *h*) of red crosses in glaze "boxing"; the cut-off corners are in the panel manner.

The one continuous pattern in the miscellaneous group (fig. 134, *c*) is made up of a red base-line from which rise four rectangular projections, each flanked by two small bird figures in glaze set upon short vertical glaze lines. Little birds of this sort are typical of Glaze IV. The vessel bearing the pattern is a border-line piece which, indeed, was catalogued in the field as Glaze III-IV. The sherd illustrated in figure 119, *e* bears what would appear to be part of a similar design.

EXTERIOR DECORATIONS IN GLAZE WITHOUT RED

These are uncommon (5 examples in 95 bowls). As a rule they are merely scrawled lines or poorly drawn units. One of the latter sort appears in figure 134, *a*; three crude, but unmistakable, human faces. Faces are perhaps also represented by the series of little triangles in figure 134, *b*; the pattern as a whole, with its four panels in A,B,A,B, alteration, follows very closely the standards of interior bands.

OLLA DECORATION

BODY

The upper body, from the shoulder to just below the spring of the neck, is always treated as a band, its lower framer, which usually lies a trifle above the point of greatest diameter, is a single glaze line of the same width as the other lines of the pattern (fig. 6, *a*). An exit space seems always to be present. There is no independent upper framing line, the band being framed above by the red stripe which is the lowermost part of the neck decoration. Often, indeed, the lower glaze border of the red stripe forms the upper banding line (see fig. 6, *a*). in other cases (fig. 135), the banding line is set a little below the red stripe. The band patterns upon olla bodies conform exactly, as far as can be determined from the scanty material, to the standards of bands on bowl interiors, i.e., they are divided by vertical open spaces or by sets of paneling lines into four panels containing alternating arrangements of the same elements used on the bowls.

NECK

The nearly vertical, collar-like neck is ornamented, as is the exterior of the bowl, with glaze bordered red figures. The lowest element of the neck decoration is

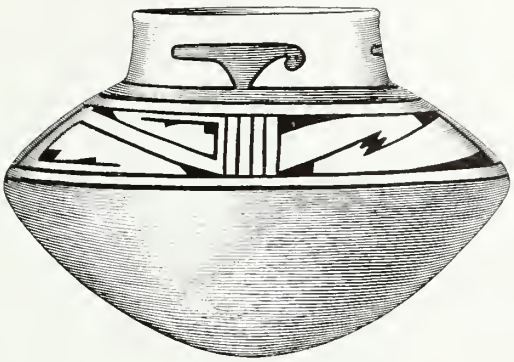


Fig. 135. Glaze III. Olla restored from fragments. (1/6)

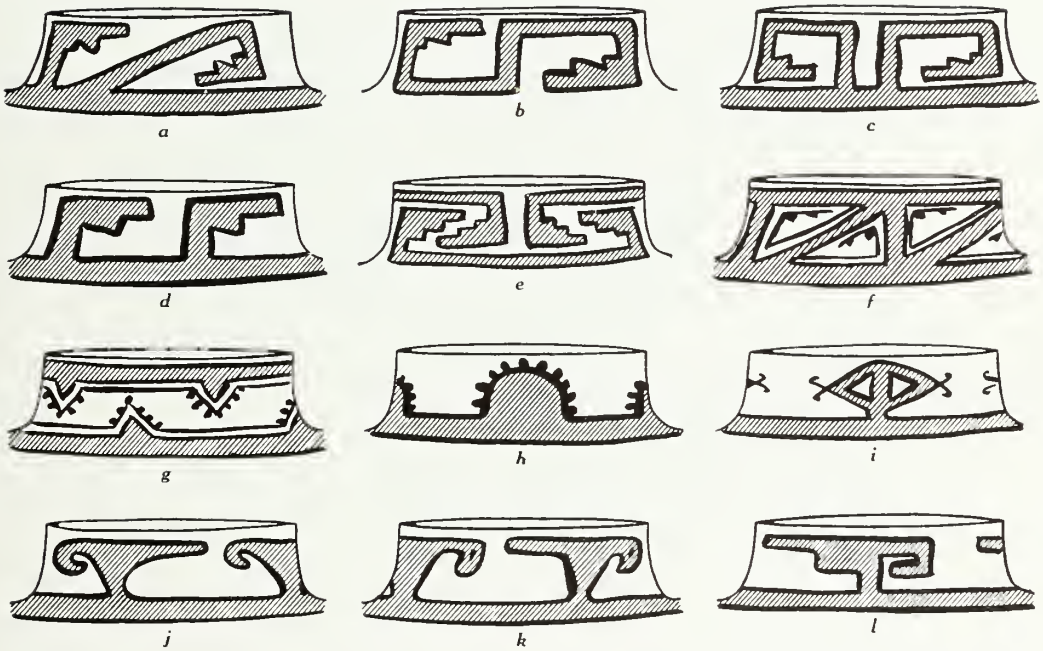


Fig. 136. Glaze III. Glaze-bordered red decorations from the necks of ollas. Drawn from sherds—the figures are accurately copied, but all are applied to a standard neck-outline. (*Ca.* 1/6)

Fig. 137. Glaze III. Typical sherds from the necks of ollas. (Width of *b*, 4 inches)

an unbroken red stripe, which encircles the uppermost part of the body (fig. 135). Often it lies in the angle between neck and body, but very seldom does it encroach on the vertical neck itself, that space being reserved for the red figures which rise from the stripe.

The red neck figures are identical with those upon bowl exteriors: double-ended keys of oblique (figs. 136, *a;* 137, *a, b, d*) and right-angled (figs. 136, *b;* 137, *c, f*) types; keys rising from a base stripe (fig. 136, *c, d*); zigzag bands (fig. 136, *f*); "sunburst" bands (figs. 136, *g, h;* 137, *g, h*); and birds red throughout (figs. 136, *j, k, l;* 137, *j, m-p*). The only neck element not observed upon the bowls is the double swallow-tail figure (fig. 137, *i*). Three depictions of human heads are found (fig. 138, *a-c*); the sherds bearing them are too small to indicate whether the heads were repeated; or whether, as seems more probable (on the analogy of a Glaze II-III olla from the Frijolito ruin[1]), they alternated with birds.

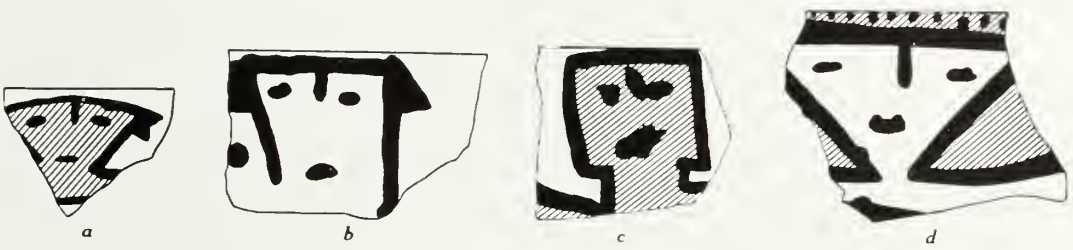


Fig. 138. Glaze III. Depictions of the human head. *a-c:* Olla necks. *d:* Head in white upon the exterior of one of the very rare red-slipped bowls. Drawn from sherds. (1/2)

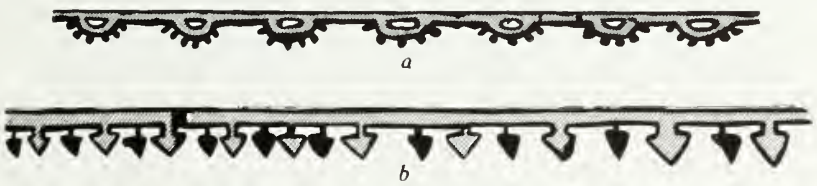


Fig. 139. Glaze III. Patterns from shouldered bowls. For photographs of these two specimens, see fig. 102, *a, b*. (1/8)

SHOULDERED BOWL DECORATION

Material is scanty; this form of vessel being distinctly rare in Glaze III. The examples shown in figures 102, *b;* 139, *b* bear an alternation of glaze-bordered red and solid glaze figures, which appear to be representations of arrowheads, pendent from a red stripe with exit space encircling the bowl just below the orifice, their tips extend downward to the point of greatest diameter. The arrowhead has not been noted on any other Glaze III vessel.

[1] Kidder, 1915, pl. XXVII, 9.

Although the elements are unique, the use of red allies this design to those upon the exteriors of standard bowls. Such few sherds as we have indicate that the decorative system of the bowl exterior was the usual model for the embellishment of the shouldered bowl, most of the pieces bearing double-ended red key figures, large red birds of the terraced tail variety or "sunbursts" (figs. 102, *a*; 139, *a*). Such devices were, however, not exclusively used, for we have several fragments with paneled bands in glaze alone, bands which seem to have differed in no way from those normally applied to the interiors of standard bowls.

GLAZE IV[1]

Although there is not the least difficulty in distinguishing fully developed Glaze IV from the run of Glaze III, much trouble is encountered when one attempts to assign to either group certain sherds and a few vessels which came, for the most part, from general digging and from graves. These specimens lie almost exactly mid-way between the two types and it is upon the evidence provided by them, rather than upon clear-cut stratigraphic findings, that one can postulate a local transition, for no definite stratum of such material was found in any test. The change therefore seems to have come quickly. Indeed, during the early years at Pecos, I believed, because of the lack of intermediate beds, and because the two types were, to the practiced eye, so different, that Glaze IV owed its presence to the taking over, lock stock and barrel, of a type developed elsewhere. And I still believe that the metamorphosis must have been stimulated and hastened by strong external influences. This problem will, of course, be considered more fully in the final discussion of the Glaze types.

Glaze IV was the first of the Rio Grande Glazes to come to the notice of archaeologists. It has received, accordingly, more attention than any other. The "coarsely glazed pottery," so often mentioned in Bandelier's Final Report[2] as occurring at ruins in New Mexico, must have been mostly of this type, for it occurs abundantly in the sherd collections which he deposited in the Peabody Museum at Harvard. Hewett's early excavations on the Pajarito Plateau resulted in the recovery of specimens from Puyé, Otowi, Tschirege, Tsankawi, and Tyuonyi. A few pieces were illustrated.[3] The material available in 1915 was described at length, under the name "Pajaritan Redware" by the present writer.[4] Nelson includes the ware in his Type III, characterizing it with his usual accuracy.[5] Pecos Glaze IV was summarily treated in the preliminary report on the pottery of that site.[6] Jeancon, although he found relatively little Glaze at Poshuouingge on the Chama, figures several pieces.[7] There are extensive museum collections.[8]

GENERAL CHARACTERISTICS[9]

The change from Glaze III to Glaze IV is marked by a shift from light to dark slips. In late Glaze III red vessels began, it is true, to appear; but in Glaze IV they are the rule. Although there is no startling break, the nodes of specialization of the two types comprise materials which are quite distinct. Glaze III is garish stuff;

[1] Comparable material is included in Mera's Group D, the type ware of which is "San Lazaro Glaze-polychrome."

[2] Bandelier, 1892. [3] Hewett, 1906, pls. XIV, XV. [4] Kidder, 1915. [5] Nelson 1916.

[6] Kidder, M. A. and A.V., 1917. [7] Jeancon, 1923.

[8] Museum of New Mexico from various ruins on the Pajarito Plateau, at Ojo Caliente, and in the Jemez valley; a representative series from Pecos is also in the New Mexico Museum. The Peabody Museum at Harvard has material from Tyuonyi; Southwest Museum from Puyé; U. S. National Museum from Pajarito Plateau and the Chama; Department of Archaeology, Andover, from Pecos. The Laboratory of Anthropology at Santa Fe possesses sherds from many sites.

[9] For Miss Shepard's technological description, see pp. 505-512.

staring red figures contrast sharply with light-colored backgrounds; Glaze IV, on the other hand, is subdued. It is, of course, a polychrome ware, even more consistently so than is Glaze III, for red regularly invades the interiors of bowls and the bodies of ollas; but the slips are of shades so dark that the effect is quietly and pleasingly harmonious. Great improvement is evident in moulding, in the brushwork of the decoration, and in the high average luster of the glaze.

To describe the colors of Glaze IV pottery in such a way as to give the reader any real idea of what the vessels look like seems, as is always the case at Pecos, next to impossible. To begin with, the variation is great, particularly in backgrounds. The red design elements are reasonably uniform in color, a rich, dark shade. But the slips upon which the decoration is applied run the whole gamut of the more subdued reds, red-browns, fawns, and tans. Against the lighter slips the red elements of the decoration stand clearly out; in most cases, however, the slips are so dark that the contrast is slight and, as a rule, harmonious; upon the deepest red slips the added red is of so nearly the same shade that it is often hard to tell whether or not it actually is present.

Firing clouds are surprisingly rare; bowls whose interiors have been darkened by lack of sufficient ventilation almost never occur. It is evident that burning was more skillfully handled than at any time subsequent to Glaze I. The same increase in technical ability is evidenced by the slip, which, although a very thin coat, masks the paste with little or none of the streaky or washy effect common in Glaze II and by no means unusual in Glaze III. Its color, too, is the same over any given vessel; it does not show crackling, nor does it often tend to flake or suffer easily from wear. Several sorts of slips seem to have been in use, for the great range in color can scarcely be attributed to differences in firing; strong variations in heat would presumably be reflected in lack of uniformity in the vitrification of the glaze. Another reason for believing that the slip emanated from more than one source is that examples of lighter color exhibit few, sometimes no, glints of mica; the deeper red slips, on the other hand, are often thickly sprinkled with tiny particles of this mineral; more so, indeed, that is the case in any Pecos Glaze type save Local Glaze I Red.

The glaze reaches a very high standard of luster. Untaken lines do, of course, occur, but they are decidedly exceptional, a clear glassy-black vitrification having consistently been attained. Running hardly ever mars the accurate presentation of patterns.

The matte red is somewhat softer and more subject both to flaking and to wear than is the slip; less so, however, than that of Glaze III and much less so than that of Glaze V.

VESSEL SHAPES

Glaze IV potters produced bowls, shouldered bowls, ollas, and a limited number of small vessels of unstandardized form.[1] The shouldered bowl, though still far from abundant, is much more strongly represented than in Glaze III.

[1] See pp. 263 to 286.

BOWLS

Moulding, as has been said, is good; many bowls are as beautifully and evenly formed as the best Sikyatki pieces from the Hopi country. In general contour the principal difference from earlier bowls lies in a more or less distinct change in angle between the vessel-wall and the rim, the wall rising in a gradual curve from the rounded bottom, the rim turning rather sharply upward or even slightly inward from the point of greatest diameter (figs. 140; 142; 143, *a'*, *b'*). The resultant angularity of profile is by no means universal, some bowls still holding to the full, rounded form characteristic of Glaze III (e.g., fig. 142, *a'*).

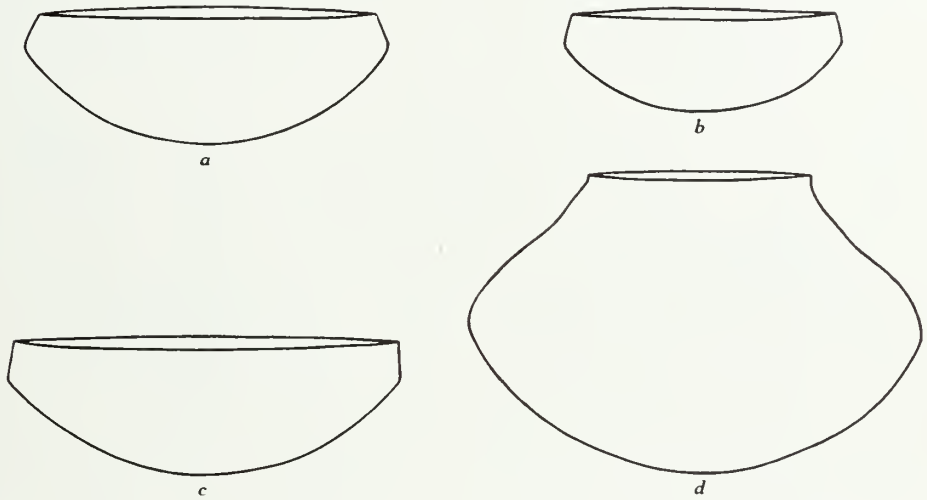


Fig. 140. Glaze IV. Vessel shapes. *a*, *b*, *c:* Bowls (examples occur with less sharply marked shoulder—see fig. 142, *a'*, *d'*). *d:* Olla. (1/6)

As in Glaze III, no distinction can be made between large and small bowls, there being a perfect gradation in size. The smallest bowl among the forty-eight measurable Glaze IV specimens has a diameter of 8¼ inches. Including this piece, there are eight between 8¼ and 9 inches, nine between 9 and 10, nine between 10 and 11, ten between 11 and 12, eight between 12 and 13, four of 13 or over, the largest being 13½. The average is just over 10½ inches (10.63 to be exact). Depths run from 3¼ inches (an 8½-inch bowl) to 6 inches (two 13-inch specimens). Extreme *orifice-depth* indices are .35 and .48; the average is .41. *Capacities:* a 13-inch specimen 5½ dry quarts (6 litres); the 10- to 11-inch bowls contain about 3 dry quarts (3.3 litres).

Rims (fig. 141) are characterized by relatively great height. The change in angle between vessel wall and rim is often abrupt (*c-g*). The outer surface tends to be straight (*d-g*), though a very slight convexity is sometimes seen (*c*, *h*, *i*); rarely

(and such pieces are apparently always early) there is a hint of outward recurve (*a*). The lip is rounded to sharp. The inner face is gently convex, never bulgy below as in Glaze III, nor plumply round as in Glaze V. There is occasionally so little difference in weight between rim and vessel wall that it is difficult to tell where the one ends and the other begins (*i*), but normally there is a pronounced thickening. *Thickness* of vessel wall is about $^{3}/_{16}$ of an inch.

OLLAS

The outline presented in figure 140, *d* is drawn from a specimen which, though far from complete, could be got sufficiently together to permit accurate reconstruction (see fig. 175, *a*). It appears, from the sherds, to be typical. There is very little break, it will be observed, between neck and body, the faint concave curve of the

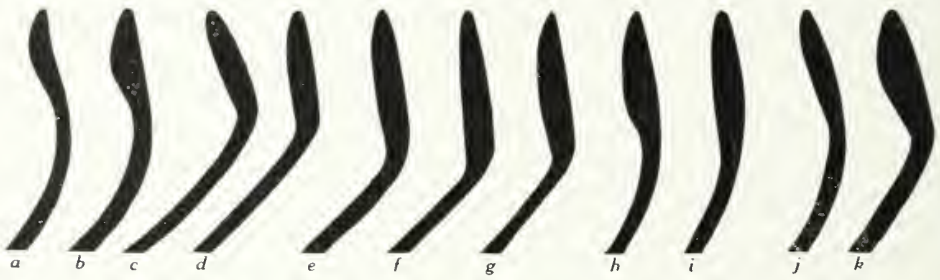


Fig. 141. Glaze IV. Bowl rim profiles. Rims *c-h*, with very flat exterior and sharp break in angle between rim and vessel wall, are most typical. Rims *a* and *b* are reminiscent of Glaze III (recurved exterior of *a;* low set thickening of *b*). Rim *k*, strongly thickened, is a late form, transitional to Glaze V. (1/2)

former reversing itself almost imperceptibly to the somewhat stronger convexity of the latter. The lower body, however, turns sharply downward from the shoulder. The angle thus produced is characteristic of Glaze IV (figs. 140, *d;* 175); it is comparable to the abrupt change of direction seen in bowls at the junction of rim and body (cf. fig. 140, *a*). The bottom is rounded, i.e., there is no flattening or recurve.

The Glaze IV olla *rim* is characteristic. There is extraordinarily little variation (fig. 144). The neck slopes inward; its wall is either straight or a trifle concave. At the orifice there is a small but pronounced outward recurve; the actual termination, or lip, is rounded; within there is a distinctly flat surface or bevel.

Approximate *measurements* can be obtained from only two specimens. The olla shown restored in figure 175, *a* has an orifice 7 inches in diameter; the diameter at the shoulder is 15 inches; the height is less certain, as the bottom is missing, but seems to have been about 9 inches. The second vessel (fig. 175, *b*): diameter of orifice, 7½ inches; diameter at shoulder, 16½; height, about 10½. *Capacities* cannot be determined.

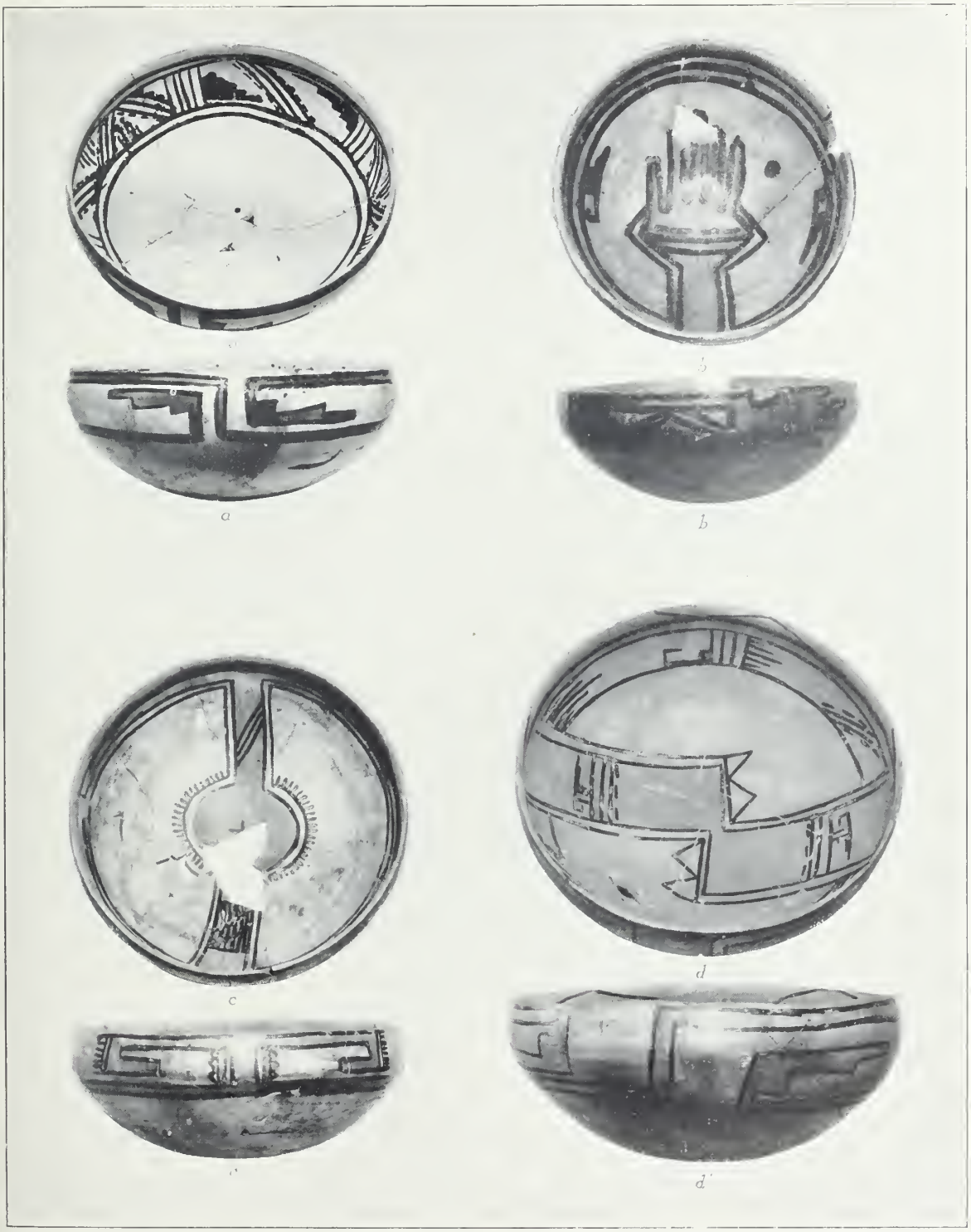


Fig. 142. Glaze IV. Bowls. *a:* Light slipped specimen apparently transitional from Glaze III. *b-d:* Typical Glaze IV bowls with all-over interior patterns. (Diam. of *d*, 13 inches)

Fig. 143. Glaze IV and Glaze V. Bowls. *a*, *b:* Glaze IV; *c*, *d:* Very early Glaze V, apparently transitional from Glaze IV. (Diam. of *a*, $12\frac{1}{8}$ inches)

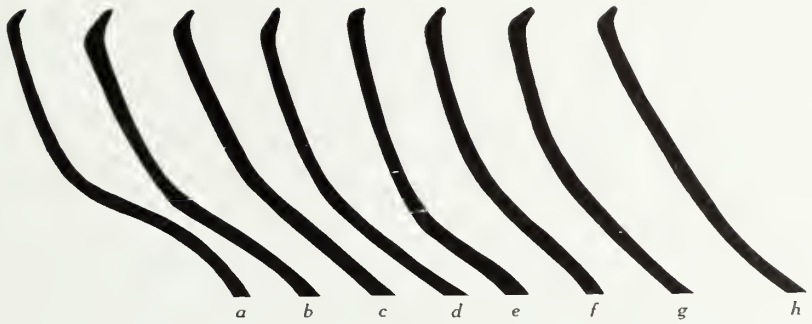


Fig. 144. Glaze IV. Olla rim profiles. Note remarkable uniformity. The slight outcurve at the orifice, the interior bevel, and the lack of distinct break between neck and body are typical. (1/2)

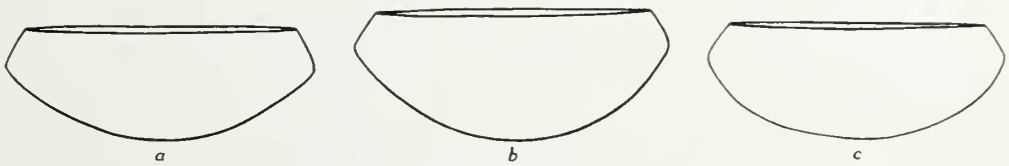


Fig. 145. Glaze IV. Outlines of shouldered bowls. Note sharp angle at shoulder. (1/6)

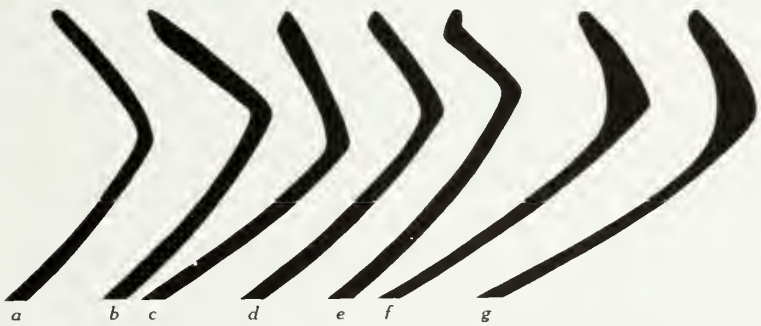


Fig. 146. Glaze IV. Profiles of the upper parts of shouldered bowls. The angular shoulder and almost straight upper wall are characteristic, as are such beveled rims as those at *b* and *c*. Shoulders thickened within (*f*, *g*) are not rare. (1/2)

SHOULDERED BOWLS

Although this form is by no means common, it is distinctly more so than in Glaze III. During Glaze V it attains its maximum representation.

The typical Glaze IV vessel has an angular shoulder (figs. 102, *c*, *d*; 145), whose point of greatest diameter lies even further above the horizontal median line than in the Glaze III prototype (about 70% of the height is below the shoulder, as against 65% for Glaze III).

Measurements of a half-dozen pieces indicate an average orifice diameter of 8 inches; greatest diameter, 9 inches; height, 3¾ inches. *Orifice-height indices* run from .42 to .47; the *greatest diameter-height index* is from .38 to .40. Capacities are from 2 to 2½ dry quarts (2.2. to 2.8 litres).

Rims vary considerably. There are a few rounded examples (fig. 146, *a*, *g*); a very few, with recurved standing rim, suggest the Glaze III type (fig. 146, *e*; cf. fig. 101, *b-e*). The commonest rim is sharp-edged, with a marked bevel (fig. 146, *b*, *c*). The most certain shape-diagnostic of Glaze IV specimens is the angular shoulder formed by the junction of the almost straight upper wall with the only slightly curved upper part of the lower body. *Thickness:* as a rule the wall is of the same thickness (3/16 of an inch) throughout the bowl; but added clay on the inside of the shoulder not infrequently brings that region to a thickness of ⅜ of an inch or more (fig. 146, *f*, *g*).

GENERAL DECORATIVE FEATURES

Colors. Dark glaze and matte red paint on various shades of red, brown, or fawn. Really light-colored backgrounds seldom occur (fig. 142, *a*; this bowl, however, as noted in the caption, is on the borderline between Glaze III and IV). A few sherds show that white pigment was occasionally used in the patterns as a substitute for red.

Slip extent. *Bowls.* Whole interior and often the whole exterior, including the bottom. The slips of Glaze IV, however, are generally so closely similar in color and texture to the paste that it is difficult to be certain where, toward the bottom, the one ends and the other begins. I once thought, indeed, that Glaze IV slip was merely untempered paste-clay, but Miss Shepard (p. 522) has shown that the paste is probably local, the slip imported.

Ollas. The upper body and neck are covered with red, brown, or fawn slip. Dark red slip, indistinguishable in color from the red pigment of the design, runs downward from the shoulder, sometimes covering the entire bottom (fig. 175, *b*, *c*), sometimes leaving a small basal area which is treated with a coat of the same slip used for the upper body (fig. 175, *a*). Entirely unslipped bottoms do not seem to occur; but, as in the case of the bowls, this point is often difficult to determine. The interior of the neck, from the lip downward for 2 to 3 inches is slipped red. The lighter-colored slips of the upper exterior are never carried into the inside of the neck.

Shouldered bowls. Occasionally slipped red over whole surface, inside and out; occasionally covered with light slip over all surfaces except exterior base; most

commonly light slip is applied from the point of greatest diameter to the rim, the whole inside of the bowl and the entire exterior bottom being coated with red.

Zones of decoration. *Bowls.* Upper part of interior from the base of the rim-thickening downward for 2 to 3½ inches; a large percentage, perhaps one-third to one-half, of all bowls carry all-over patterns. The exterior bears free-standing repeated units, units upon a base stripe, or bands, all of which are set close below the edge of the rim. The lower edge of the exterior pattern seldom extends below the level of the base of the rim. The interior of the rim is much less commonly decorated than is the case in Glaze III; when such embellishment occurs it usually takes the form of a zigzag or festooned line (see fig. 147, *d*, *f*).

Ollas. Whole upper exterior from point of greatest diameter to orifice, the surface being divided into two horizontal zones, one about the upper body, the other encircling the neck (fig. 175).

Shouldered bowls. The narrow zone (1 inch to 1¾ inches wide) which lies between the point of greatest diameter and the edge of the rim. The interior is never decorated, save for groups of ticks on the beveled inner surface of the rim.

BOWL INTERIOR DECORATION

Sixty-six Glaze IV bowls were recovered in more or less complete condition. They show a remarkable increase of the all-over method for the decoration of interiors, with a corresponding decline in the popularity of the band:

Bands	24
Pendent units	8
Pendent triangles	2
All-over patterns	32
	66

BAND PATTERNS

Glaze IV decoration is in all ways a freer and more vigorous art than that of the preceding periods. The emancipation of the potter from old traditions manifests itself most clearly in relaxation of slavish adherence to the band. And in the bands that do occur there is a pleasing variety of treatment; paneling, for example, is not the absolute rule, red elements enliven many of the designs.

Framing. The upper framing line of earlier times is retained and a lower framer, seldom seen before, terminates the band below. But these lines, instead of standing free, are often reduced to the humble role of margining, at top and bottom, two heavy red stripes which are edged on their two inward sides by the old banding lines (fig. 147, *f*, *g*). Red, in such cases, accordingly becomes the real framing device; and as a rule it is only absent in the case of bowls so dark-colored that it would not produce an effective contrast. The exit space assumes greater importance than ever before. It often interrupts both the upper and lower framers; the glaze bordering lines carry around, and still further emphasize, the break.

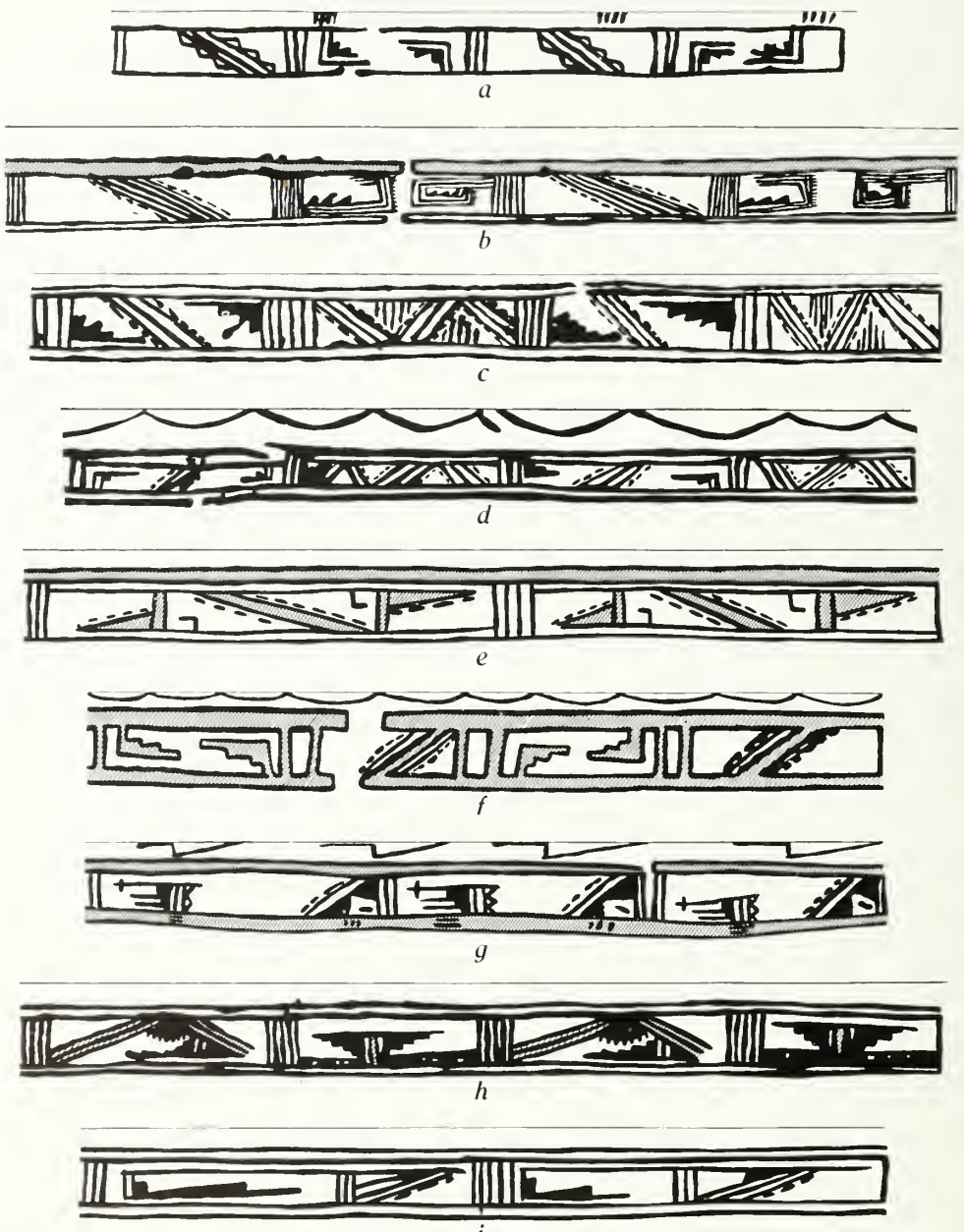


Fig. 147. Glaze IV. Band patterns from bowl interiors. Characteristic features are: common use of red stripes as framers; paneling by sets of several vertical lines; general lack of standardization. For exterior decoration of *a*, see fig. 159, *a*; of *b*, fig. 172, *c*; of *c*, fig. 160, *d*; of *d*, fig. 171, *d*; of *e*, fig. 160, *h*; of *f*, fig. 162, *e*; of *g*, fig. 171, *c*; of *h*, fig. 169, *b*; of *i*, fig. 162, *c*. (1/8)

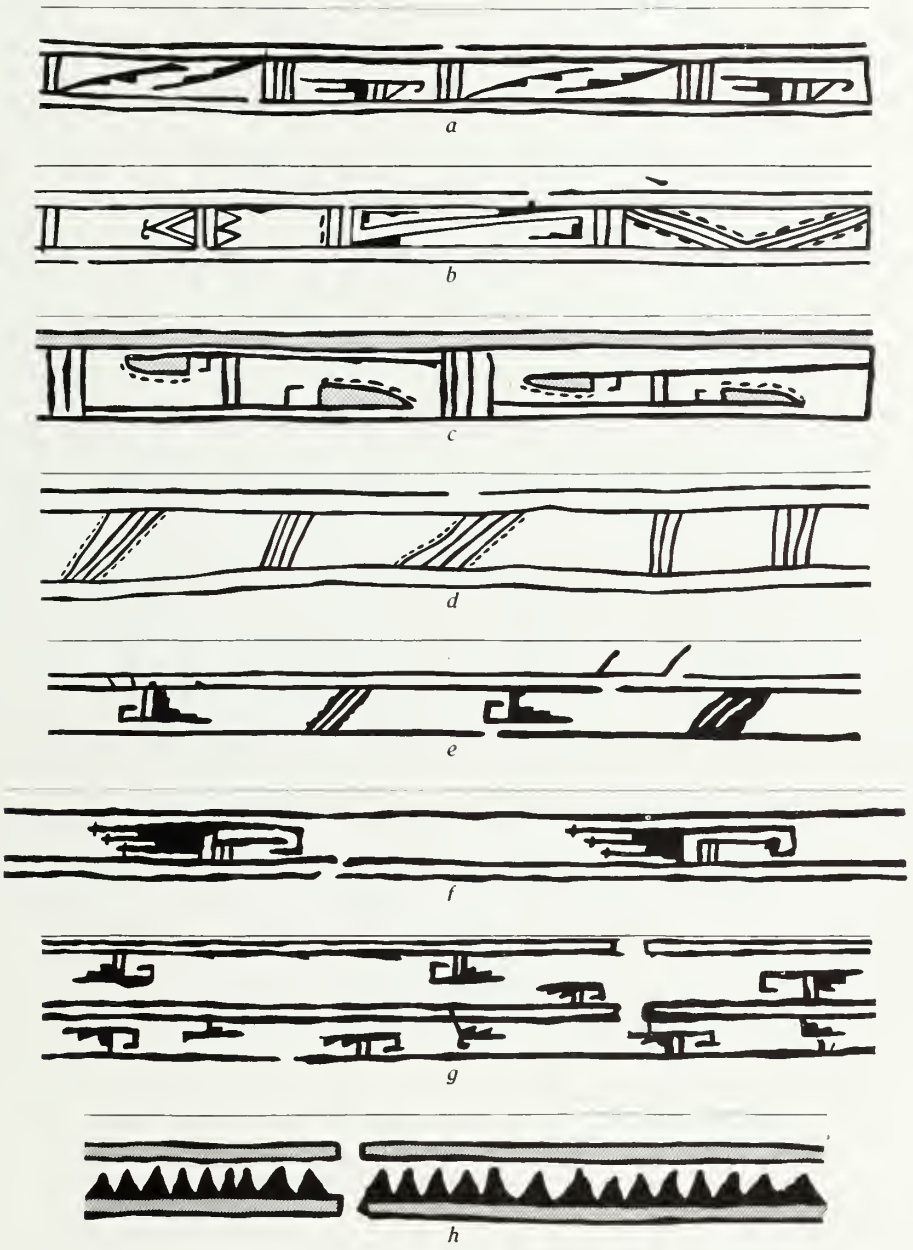


Fig. 148. Glaze IV. Band patterns from bowl interiors. *a-c:* Paneled bands. *d-h:* Unpaneled bands. For exterior decoration of *a*, see fig. 171, *b;* of *b*, fig. 171, *g;* of *c*, fig. 160, *b;* of *d*, fig. 171, *e;* of *e*, fig. 163, *e;* of *f*, fig. 171, *h;* of *h*, fig. 159, *f*. Exterior of *g* not reproduced. (1/8)

Paneling. Multiple paneling lines, in groups of three to six, which appear sparingly in late Glaze III, are habitually used for the subdivision of Glaze IV bands. Panels are still usually four in number and they still preserve the old A,B,A,B arrangement, but two-panel (fig. 147, *e*, *i*) and three-panel (*g*) bands are commoner than in any earlier Glaze, and alternation is not so stringent a requirement.

Panel layout. In the embellishment of the panel there is seen a notable divergence from former practice. In the Glaze I, II, and III periods the panel was subdivided by lines, almost always emanating from diagonally opposite corners, said lines either producing fields for intensive embellishment, or serving as stalks for various sorts of opposed or slung elements. These oblique preliminary layouts left vacant the other two corners of the panels, which, because of the intense *horror vacui* of the early Glaze potters, were habitually cut off obliquely and filled. The resultant corner-triangles in solid glaze are characteristic of Types I to III. Glaze IV panels are entirely different. They are no longer subdivided from corner to corner; opposed keys on stalks, slung birds and other such devices have been discarded, and their place is taken by pairs of keys rising from the upper and lower banding lines respectively; by series of oblique lines connecting the banding lines; or by zigzags. Other panels serve to hold single elements. In the case of the paired keys and in most of the zigzags the corners of the panels are more or less filled by the devices themselves. Hence there is no need for the corner-triangle. In the oblique-line arrangement it is simply omitted. Nor do panels whose only adornment is the corner-triangle ever, apparently, occur (these, it will be remembered, were abundant in Glaze III).

There seem to be but four common methods for filling panels. My qualification of this statement is due to paucity of data regarding panels. Band patterns, to begin with, are not abundant, nor are they by any means always paneled. Therefore we glean relatively little information from the whole bowls. And the sherds do not add a great deal, for the vessel walls of the Glaze IV bowl, being thin, break into small fragments. Our sherd material is accordingly for the most part restricted to rims, which well illustrate the high-placed exterior designs, but which seldom carry more than the upper framing stripe of the much lower-set interior patterns.

The above-mentioned four methods for treating panels are:

Paired keys
Birds
Zigzag lines
Oblique lines

Paired keys (fig. 149, *a-f*). The two units, instead of tipping long stalks emanating from diagonally opposite corners of the panel, as was the consistent practice from Glaze I through Glaze III, are set on short stalks which come from the upper and lower banding lines respectively. The keys are opposed, but they are usually placed so far apart that their steps do not assume the almost interlocking position of earlier treatments; in some instances, indeed, oblique lines separate the keys (fig. 149, *c*, *d*).

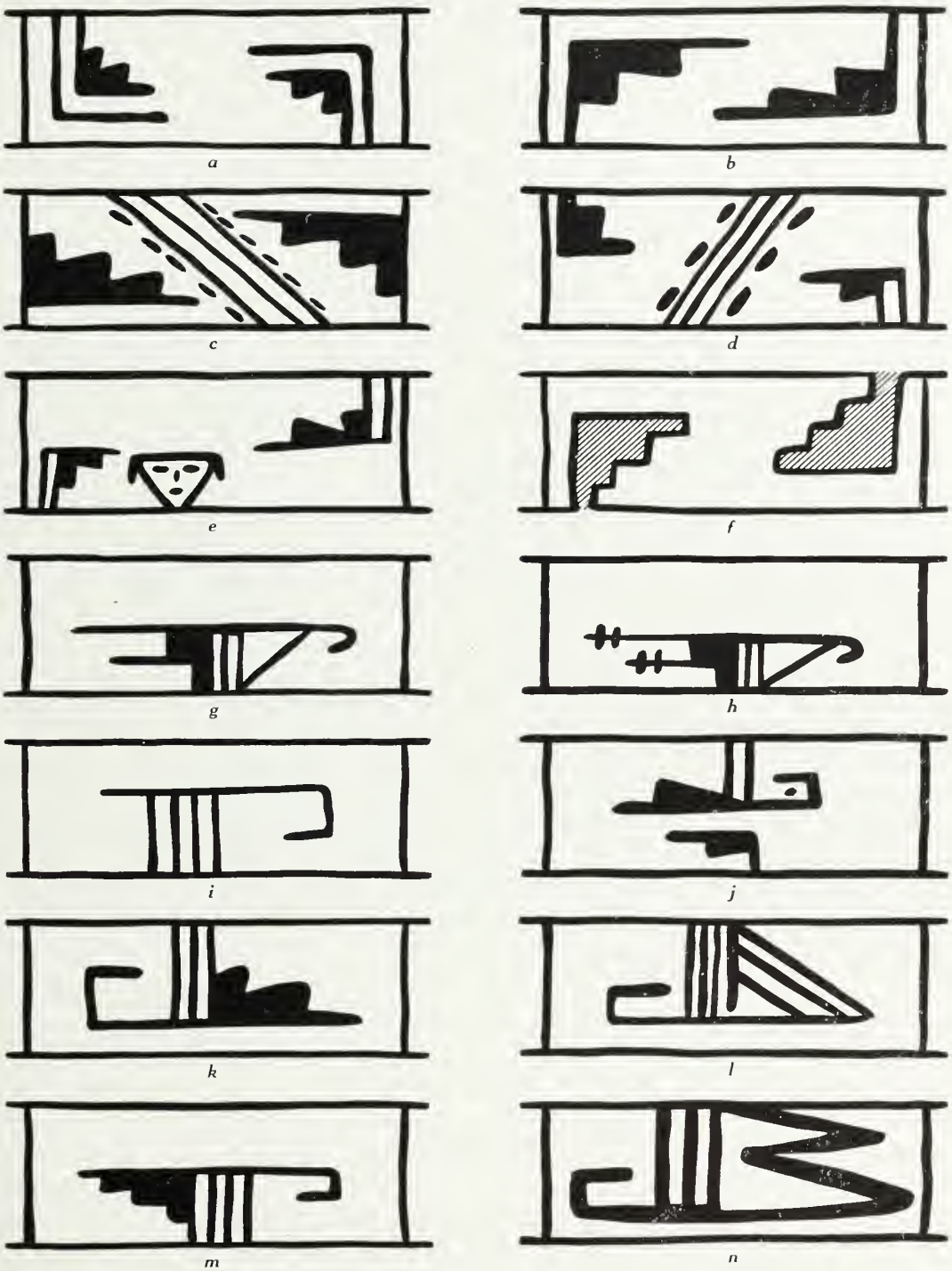


Fig. 149. Glaze IV. Panels from band patterns. *a-f:* Opposed keys. *g-n:* Pajaritan birds.

Birds (fig. 149, *g-n*). A single bird, normally of the Pajaritan type (see p. 139 and fig. 120), is often the sole occupant of a panel. It stands on the lower or hangs from the upper banding line. We have, as it happens, few examples of single-bird panel fillers upon the whole bowls (fig. 148, *a*), but the sherds prove it to have been a reasonably common practice. Other figures, which seem always to have keys or elements resembling birds' tails as component parts, sometimes replace the bird (fig. 150, *i*, *j*, *l*).

Zigzag lines (fig. 150, *a-d*). Common. The length of the panel determines, of course, the length of the zigzag. As a rule there is room for, to dichotomize the term, two zigs and one zag. Three or four parallel lines constitute the zigzag, the two outer ones edged by dashes.

Oblique lines (fig. 150, *e-h*). Very common. This differs from the oblique line treatment of the older Glazes in that a set of parallel lines rather than a single line crosses the panel. The lines, furthermore, constitute a decorative element in themselves more commonly than is the case in former times, when the line generally served merely as a method of subdividing the panel. Still another difference is that the lines connect the banding lines, instead of emanating from diagonally opposite corners of the panel. Lastly, the corners of the panel are never filled solid, as was the almost invariable earlier practice. The various ways of embellishing the lines will be considered below (p. 183).

UNPANELED BANDS

As has been said, the rigid paneling convention breaks down, to a considerable extent, in Glaze IV. Unpaneled bands (fig. 148, *e-h*) are framed in the same ways as the more conventional bands, i.e., with red stripes above and below, or by upper and lower framing lines of glaze without red. The decoration in some cases reflects panel practice in the alternation of such panel elements as birds and oblique lines; but they are not separated from each other by paneling lines (fig. 148, *e*). Other bands have series of small birds (*g;* further examples among the sherds). The band at *h*, with its closely set small glaze triangles on the lower red framing stripe, represents a rare but, according to the sherds, not a unique treatment.

PENDENT UNIT PATTERNS

These (fig. 151, *a-f*) seem from the sherds to be about half as common as bands. A red stripe, normally with wide exit space, encircles the bowl at the base of the rim-thickening. From it, or from a glaze line closely paralleling its lower glaze border, hang birds (fig. 151, *a*) or peculiar triangle-and-tail figures (*b-d;* for description see p. 186). The pattern at *f*, in which pendent units are replaced by pairs of horizontal dashes, is seen upon several sherds.

PENDENT TRIANGLE PATTERNS

The frequency of this pattern is hard to gauge, for upon small sherds, parts of it cannot be distinguished from sections of bands. The two whole examples (fig. 151, *g*, *h*) are so similar to each other that one can readily believe the pattern to have

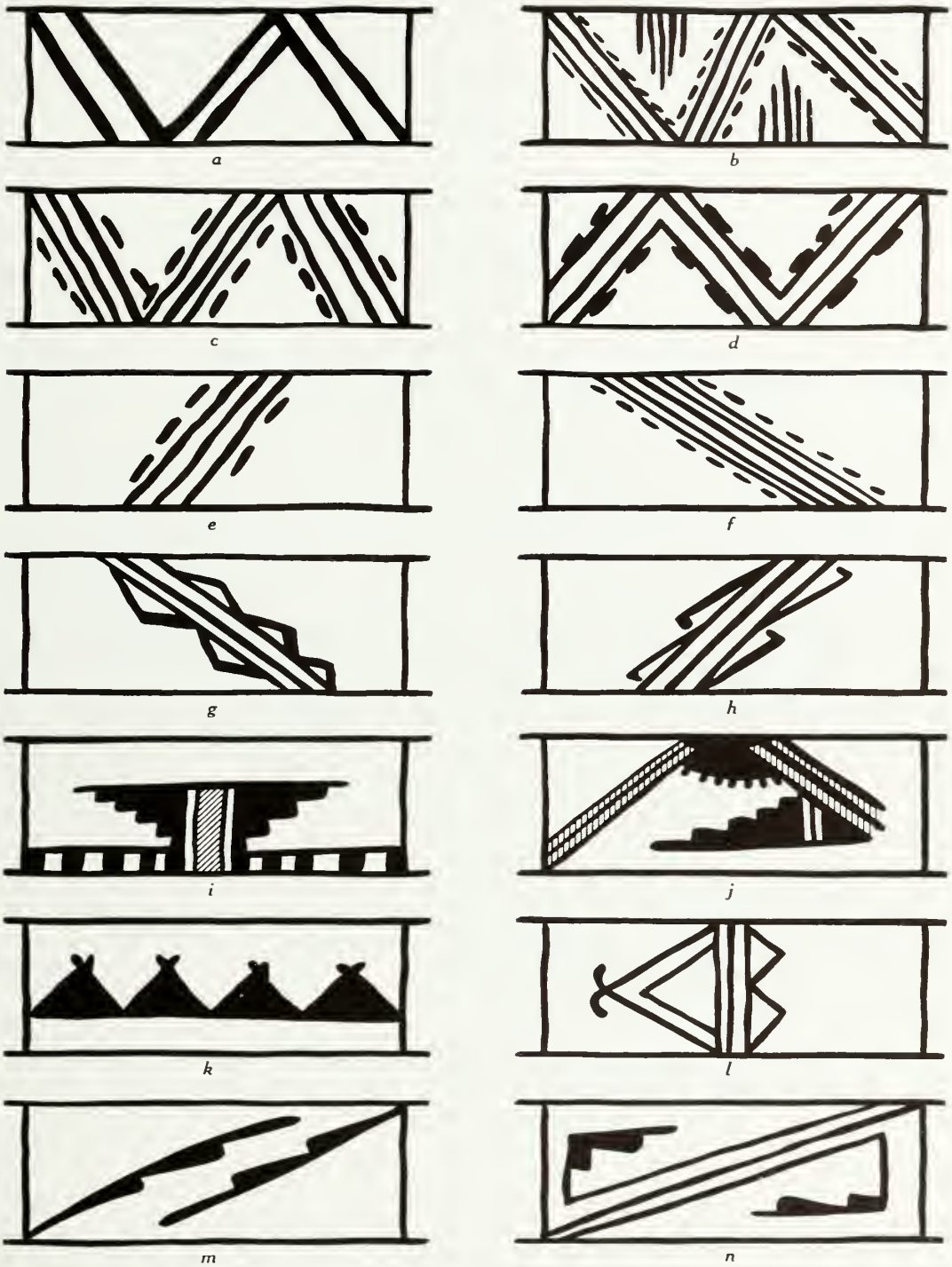


Fig. 150. Glaze IV. Panels from band patterns. *a-d:* Zigzags. *e, f:* Oblique lines with longitudinal dashes. *g:* Oblique lines with triangles. *h:* Oblique lines with birdlets (for other methods of treating oblique lines, see fig. 156). *i-n:* Unusual panel treatments.

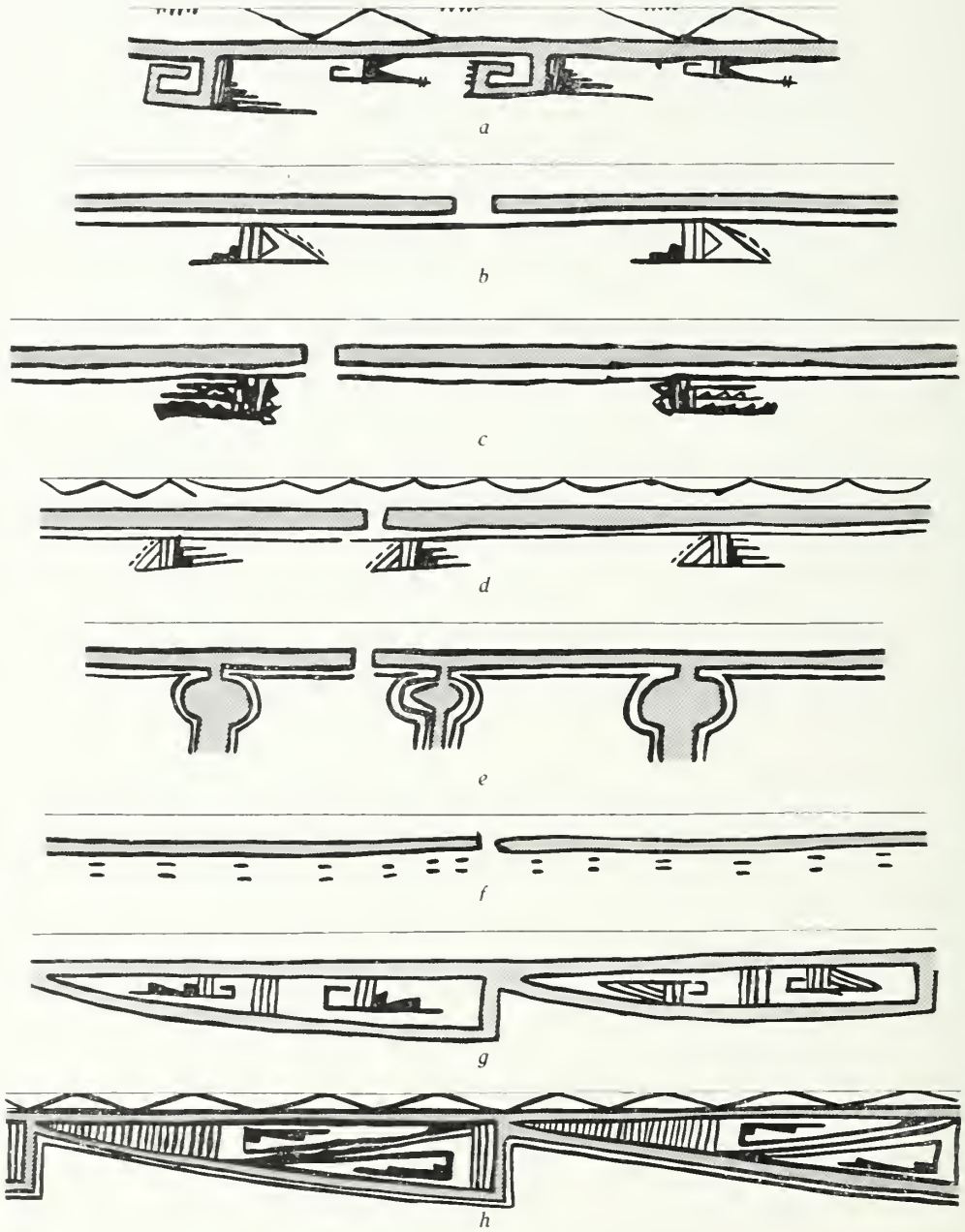


Fig. 151. Glaze IV. Non-band patterns from bowl interiors. *a:* Pendent birds. *b-d:* Pendent triangle—and tail figures. *e, f:* Two unique arrangements. *g, h:* Pendent triangles. For exterior decoration of *a*, see fig. 160, *i;* of *b*, fig. 172, *b;* of *c*, fig. 159, *d;* of *d*, fig. 162, *g;* of *e*, fig. 159, *e;* of *f*, fig. 163, *c;* of *g*, fig. 162, *b*. Exterior of *h* not reproduced. (1/8)

been in regular use. Its general layout, of two long triangles placed end-to-end and encircling the bowl, is exactly like that of the Glaze I pendent triangle decorations (figs. 19, 20, 47, 48), and the enclosed field is also treated, as well as its taper will permit, in the manner of a band. It will be remembered that pendent triangle patterns degenerated sadly in Glaze II, becoming practically extinct in Glaze III. Their renaissance in Glaze IV is therefore surprising. It may perhaps have been brought about by copying old pieces kept as heirlooms in the pueblo (we have a record of a Glaze I Red olla which was in possession of the Pecos as late as the historic period) or the pattern might have persisted elsewhere and have been reintroduced.

ALL-OVER PATTERNS

These are handsome, boldly conceived designs executed in red, outlined, and often intensively ornamented, with glaze. There are sherds which show that a few bowls with very dark red slip bore all-over patterns in glaze alone. The circular field of the bowl's interior is ringed just below the rim-thickening by a broad red stripe interrupted, in most cases, by a prominent exit space. From the red line a large red device, or an identical pair of such devices, extends into or across the central field. Two patterns are used very commonly, certain others appear less frequently, and there are a few unique arrangements, which seem to be products of individual fancy.

Jogged crossbar (fig. 152). On the evidence of the sherds, this was the most popular of the all-over treatments. A broad red bar, connecting opposite points on the encircling stripe, crosses the central field, making two right-angled changes of direction in the process. In addition to the glaze lines, which margin the red parts of the pattern, a supplementary glaze line always clings close to the peripheral red stripe and closely follows the bar in its indirect course across the bowl. Upon this are often found two birds. They ordinarily perch upon the points of the jogs, facing in opposite directions (fig. 152, *c*, *e*, *f*); in such cases they are small, simple figures. In other specimens two larger, more elaborate birds (*a*, *d*, *g*) or two double-tail figures (*b*) hang downward from the encircling line in the manner of the pendent units illustrated in figure 151, *a-d*. Glaze embellishment is also regularly applied over the red pigment of the crossbar. In one instance two small birds are so placed (fig. 152, *d*); in several others there are lines crossed at the end (*a*, *c*, *e*, *g*, *h*), strongly suggesting the tails of the bird with red forepart (see p. 193 and figs. 163, 164).

Capitan (fig. 153). Only two examples of this interesting figure were found in the Glaze III collection, one in an all-over pattern (fig. 117, *f*), the other on a bowl exterior (fig. 134, *g*). It appears commonly in Glaze IV, abundantly in Glaze V. In a former publication I called it the "three finger design."[1] This is an unfortunate name, for the depiction is certainly not that of a hand. I have accordingly substituted the Spanish word for captain or chief, a term which my Mexican workmen, noting their anthropomorphic features and plume-like appendages, gave to the Glaze V specimens.

The Glaze IV *capitan* occurs both on the exteriors and interiors of bowls. I have but one record of its presence on a Pecos olla (fig. 177, *a*). The make-up of the

[1] Kidder, 1915, p. 444, fig. 19 and pl. XVII, 1.

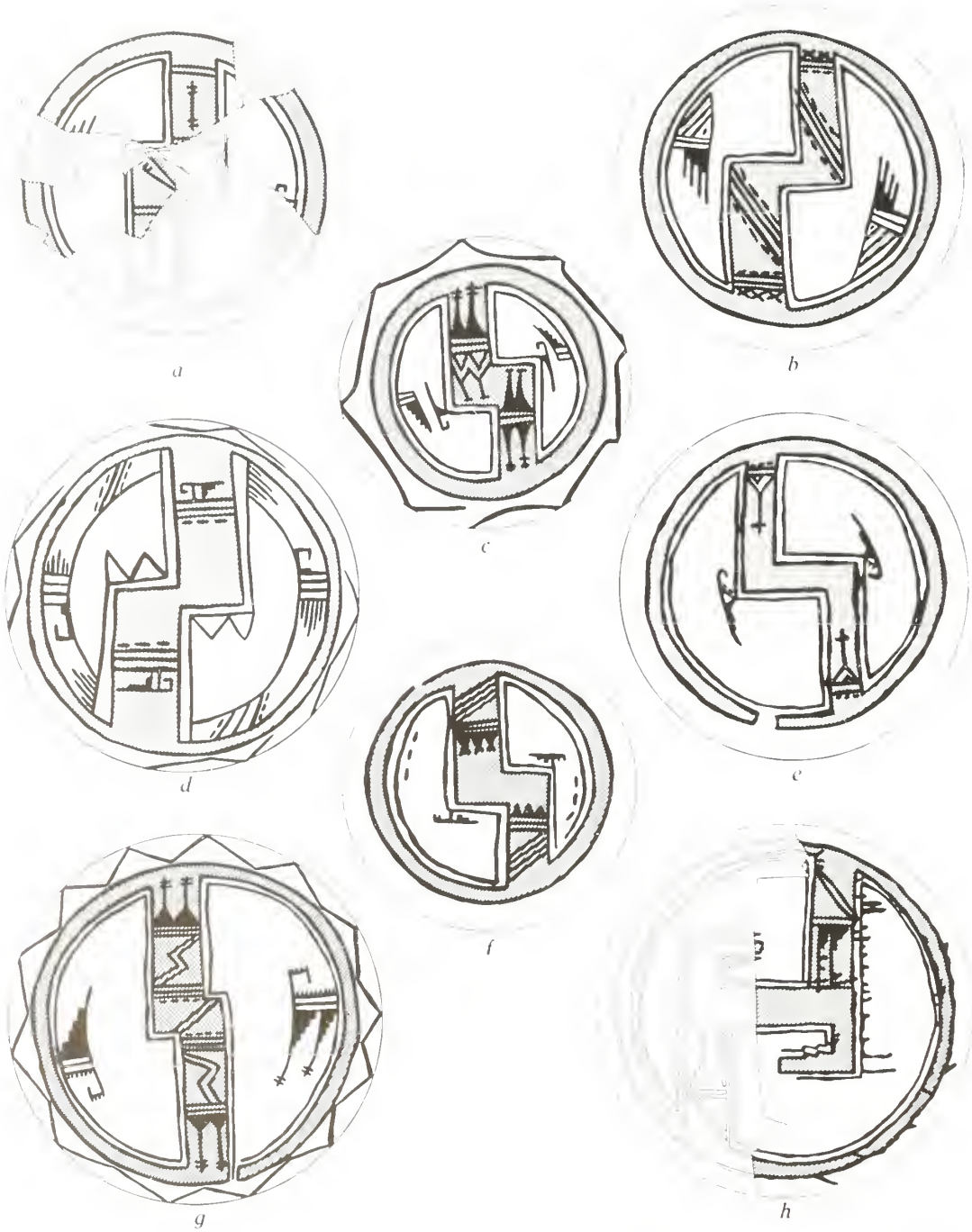


Fig. 152. Glaze IV. All-over patterns from bowl interiors: the jogged-band. Note prevalence of paired bird figures. The drawing of elements in glaze over the red parts of designs is characteristic of Glaze IV. For exterior decoration of *a*, see fig. 160, *i*; of *c*, fig. 172, *g*; of *d*, fig. 167, *i*; of *e*, fig. 167; of *f*, fig. 162, *i*; of *g*, fig. 163, *f*; of *h*, fig. 163, *i*. Exterior of *c* not reproduced. (1/8, 1/6)

Fig. 153. Glaze IV. All-over patterns from bowl interiors: *Capitans*. For exterior decoration of *a*, see fig. 162, *f*; of *b*, fig. 162, *a*; of *c*, fig. 163, *d*; of *d*, fig. 169, *d*; of *e*, fig. 163, *b*; of *g*, fig. 163, *a*; of *h*, fig. 159, *g*. Exterior of *f* not reproduced. (1/8-1/6)

Fig. 154. Glaze IV. All-over patterns from bowl interiors. *a-e:* Rare or unique types. *f-h:* Hand (?) symbols. For exterior decoration of *a*, see fig. 160, *a;* of *b*, fig. 162, *h;* of *c*, fig. 171, *f;* of *d*, fig. 163, *f;* of *e*, fig. 160, *e;* of *f*, fig. 163, *g;* of *g*, fig. 160, *g;* of *h*, fig. 162, *d*. (1/8-1/6)

figure, whether interior or exterior, is strikingly consistent: it is always in red, margined with glaze; its essentials are a rectangular body and a triangular, quadrilateral, or round head with three long, blunt-ended projections. On bowl interiors, where it was used as an all-over decoration, it was almost, if not quite, as popular as the jogged crossbar. The body, like the crossbar, strikes from the red encircling stripe straight into the bottom of the bowl, the head lies slightly beyond the middle, and the appendages reach nearly to the stripe on the opposite side (fig. 153). Again as in the crossbar, there is usually a supplementary glaze line paralleling the sides of the body and swinging about the bowl just within the encircling stripe. The body terminates in a short neck, from which rises the head; often, however, in the all-over

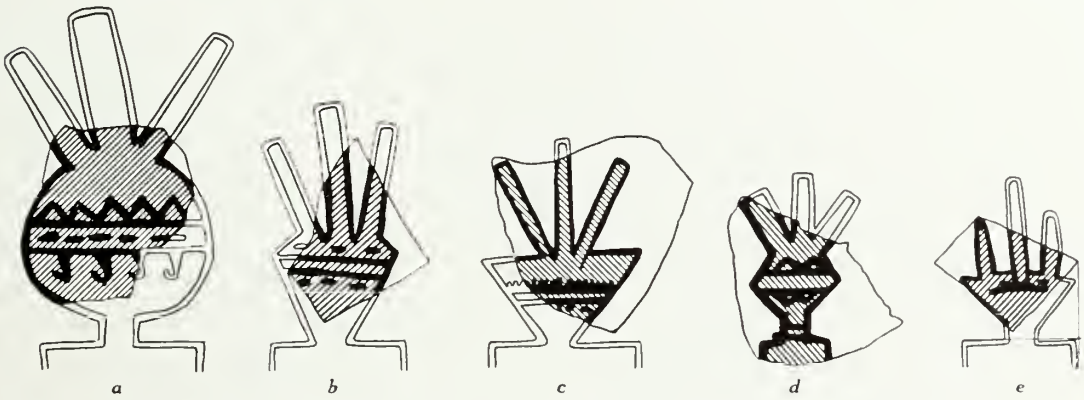


Fig. 155. Glaze IV. *Capitan* heads from bowl interiors. (1/4)

capitans, the head is attached directly to the body (fig. 153, *a*, *b*, *d*, *e*). If the head is triangular, its apex may be toward (*f*) or away (*e*) from the body; if quadrilateral, one corner joins the body (*b*). The projections are rounded or blunt, rarely pointed. The middle one is the longest of the three; it continues the line of the body, the two shorter ones usually diverging to right and left (all three are sometimes parallel, see the example at *g*). Supplementary detail in glaze over the red is always present. On the head it generally takes the form of cross-lines embellished with dots or series of little triangles (*b*, *c*, *d*); one head bears a small bird (fig. 155, *e*), another a ticked circle with central cross (fig. 153, *g*). The body is plain or ornamented; in one of the latter cases (fig. 153, *e*) there are the same cross-ended, tail-like lines so often seen in the jogged crossbar. Further resemblances to the jogged crossbar are: presence of birds or double-tail figures, usually two, on the supplementary line (*b-e*); small birds on the corners of the head (*g*).

The *capitans* at *a* and *d* of figure 153 are aberrant. The double arrangement at *a* has affinities to certain presentations of the hand figure (cf. fig. 154, *f*, *g*). It also has the bracelet-like lines characteristic of hands. The five-pointed *capitan* (fig. 153, *d*), the only one of its kind on vessel or sherd, is probably the result of an error in

the application of the red; in no other particular does it differ from the typical *capitan*.

Hand (fig. 154, *f-h*). The "fingers" of the figures which, as in Glaze III (fig. 117), I have called hands, bear resemblance to the terminations of the *capitan*. But the fact that these appendages, as shown by sherds, are usually pointed rather than square-ended, as in the *capitan;* and the consistent difference in their number of five as against three; makes it seem reasonably certain that the two sorts of depictions should be differentiated. The sherds indicate that hands were less commonly used than were *capitans;* their treatment is also less standardized. The "bracelet" of the Glaze III hands persists in the form of dotted or plain cross-lines at the wrist. As a rule, two hands are present in the decoration of any given bowl: in one instance they come from opposite sides of the encircling stripe (fig. 154, *g*), in another they are attached to the ends of a red stripe whose involutions fill most of the field (*f*). There are sherds which seem to show that a single large hand was sometimes used, presumably placed centrally, in the *capitan* manner. Bowl *h* is peculiar; the "bracelet," the four long, curved "fingers" and the short "thumb" serve, however, to suggest that the central curvilinear figure was meant to represent a hand.

Miscellaneous all-over patterns (fig. 154, *a-e*). Description of these specimens is unnecessary, their similarities to and their differences from the commoner forms may be seen in the drawings. No two of them are alike. It is accordingly probable that they are either unique, or belong to categories of patterns much less frequently used than the jogged bar, *capitan*, and hand. It is difficult to gather data as to all-over patterns, save from complete or nearly complete bowls, because the elements significant for their classification were painted upon the bottoms of vessels, which usually broke into smaller fragments than did the thickened rims; also, one cannot restore figures so variable with the same confidence that one has in dealing with the narrower and more rigidly standardized bands.

ELEMENTS OF BOWL INTERIOR DECORATION

Lines. There is not a great deal of difference in weight of line between Glaze III and Glaze IV. In both types the ordinary stroke is about $^{3}/_{16}$ of an inch wide, but lines as narrow as $^{1}/_{8}$ of an inch are certainly more frequently encountered in Glaze IV. In average accuracy of brushwork, however, Glaze IV is definitely superior, some specimens even approaching the high standards of Glaze I. This may perhaps in part be due to some quality of the glaze, which allowed it to render more freely and evenly from the brush; but the greater excellence of the painting is essentially a manifestation of the general increase in ceramic ability that marks the Glaze IV period.

Independent glaze framing lines and the glaze borders of red framing stripes were drawn, as in Glaze III, with long, trailing strokes, or were produced by a succession of shorter ones. The even flowing of the glaze, however, resulted in more nearly perfect junctions of successive increments, so that data as to length of stroke and direction of the painting are not easily gathered. Although the glaze did not

often run upon firing, it occasionally spread a little, producing a locally widened line; dots sometimes coalesce, angles occasionally blur. A bad case of running may be seen in figure 152, *h*.

Although the line serves primarily for structural layout, its common use in zigzag and oblique panel-fillers, in series for cutting the band into panels, and in various parts of bird figures, gives it greater importance than in Glaze III. Hatching and crosshatching do not occur.

Dots, Ticks, and Dashes. The round dot, so outstanding an element of Glaze I decoration, decreases in importance during Glaze II and III; in Glaze IV it has almost disappeared as an edging for lines, its only regular use being for the eyes of birds and for spots in birds' bodies. The tick persists as a rare method for fringing oblique lines. Its one habitual employment is upon the heads of birds. The dash comes into its own. This short, independent line with rounded ends plays several roles. It largely replaces the dot as an embellishment for lines (fig. 156, *a-d*) and for the bodies of birds; it is often painted in pairs and threes over the pigment of red stripes; it is grouped in various ways to form small designs (fig. 180, *j-l*).

Crosses, made by drawing two dashes at right angles to each other, appear commonly as a minor embellishment, particularly upon the red parts of all-over patterns (figs. 153, *g*; 154, *b*). One or two dashes across the end of the terminal line or lines of many birds' tails, produce cross-like effects (e.g., fig. 154, *g*); as do the crossed ends of the short lines forming one of the line-edgers next to be described (fig. 156, *k*, *l*).

Line-edgers (fig. 156). This term is coined to designate a group of elements characteristic of Glaze IV. Lines, particularly oblique lines, in the earlier Glazes are often dotted or ticked; in Glaze IV their embellishment becomes much more elaborate. The dashes mentioned above are especially abundant. They are set end-to-end in series of from two to four or five, the series closely paralleling, but very seldom touching, the line (fig. 156, *a-d*). Dotted (*e*) and ticked (*f*) lines are not often seen. Series of small triangles (*g*, *j*), short lines whose ends cross (*k*, *l*), triangles with two little appendages upon their apexes (*i*), short curved lines (*m*), all serve to enrich the outer edges of the outer lines in the oblique sets which so frequently are alternated with paired keys or with birds in the paneled bands (e.g. fig. 147, *b*). Another common line-edger is the birdlet (fig. 156, *n-s*). Used, as a rule, in series, this figure has a very simple make-up; right-triangular body with hypothenuse on the line to be decorated, next longest side produced beyond the body and bent once (*n*, *q*, *r*) or twice (*p*) at right angles to indicate the head. In some cases there are two short lines at the head (*o*); occasionally the body is omitted, a mere line bent at the end forming what, if it be indeed the representation of a bird, is certainly the ultimate possible simplification of that figure (*s*). Other line-edge birdlets are illustrated in figure 157, *a-h*.

Birds. The line-edge birdlet has just been considered, the birds characteristic of bowl exteriors and olla necks will be described below. There remain three varieties: the Pajaritan bird, the accessory bird, and the triangle-apex bird.

Pajaritan birds take their name from the Pajarito Plateau, whose pottery of this general period bears many examples of the sort about to be described. At Pecos

they are apparently somewhat less common. As in the Glaze III examples (fig. 120) there is a set of vertical lines suggesting legs; a single line at right angles to these forms the top member of the tail and continues forward to bend twice at right angles to produce the head. The tail is the most variable element: it may be a single line (fig. 149, *i*) or two lines with terracing between them (*g*); it may be a key-like appendage (*j*, *k*, *m*) or may assume single (*l*) or double triangular form (*n*). The ends of the tail-lines may be crossed (*h*—a sherd shows a second instance of this practice), as in the birds with red forepart (cf. fig. 164, below). In our unfortunately very

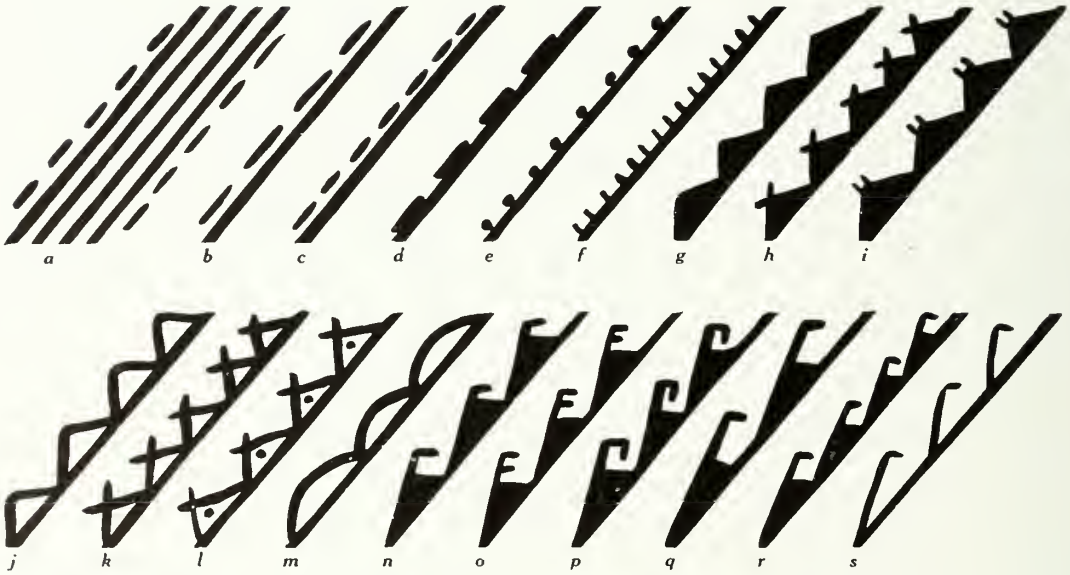


Fig. 156. Glaze IV. Treatments of the oblique line. At *a* is shown a typical set of oblique lines as used to decorate a panel (cf. fig. 147, *b*); each of the remaining drawings represents the outer upper line of a similar set. *b-d:* Dashes. *e:* Dots. *f:* Ticks. *g-l:* Triangular arrangements. *m:* Curvilinear treatment. *n-s:* Birdlets. Not to scale.

small collection of specimens illustrating the Pajaritan bird, there is but one case of the eye-dot (fig. 149, *j*).

Accessory birds (fig. 157, *i-m*, *o*) are found, as far as I am aware, only in all-over patterns and in the various sorts of red exterior patterns, where they are always minor elements in a larger figure or design. They are similar to the Pajaritan birds, but are greatly reduced in size and much simplified. The several vertical lines, or legs, of the Pajaritan bird become two stumpy supports; the horizontal line is bent once (fig. 157, *i*), or twice (*k*) for the head; the tail is a backward continuation of this line with a small area at its junction with the upright filled with glaze to give it a key-like effect (*i*, *l*, *m*). Birds of this variety seem always to appear in pairs: on the

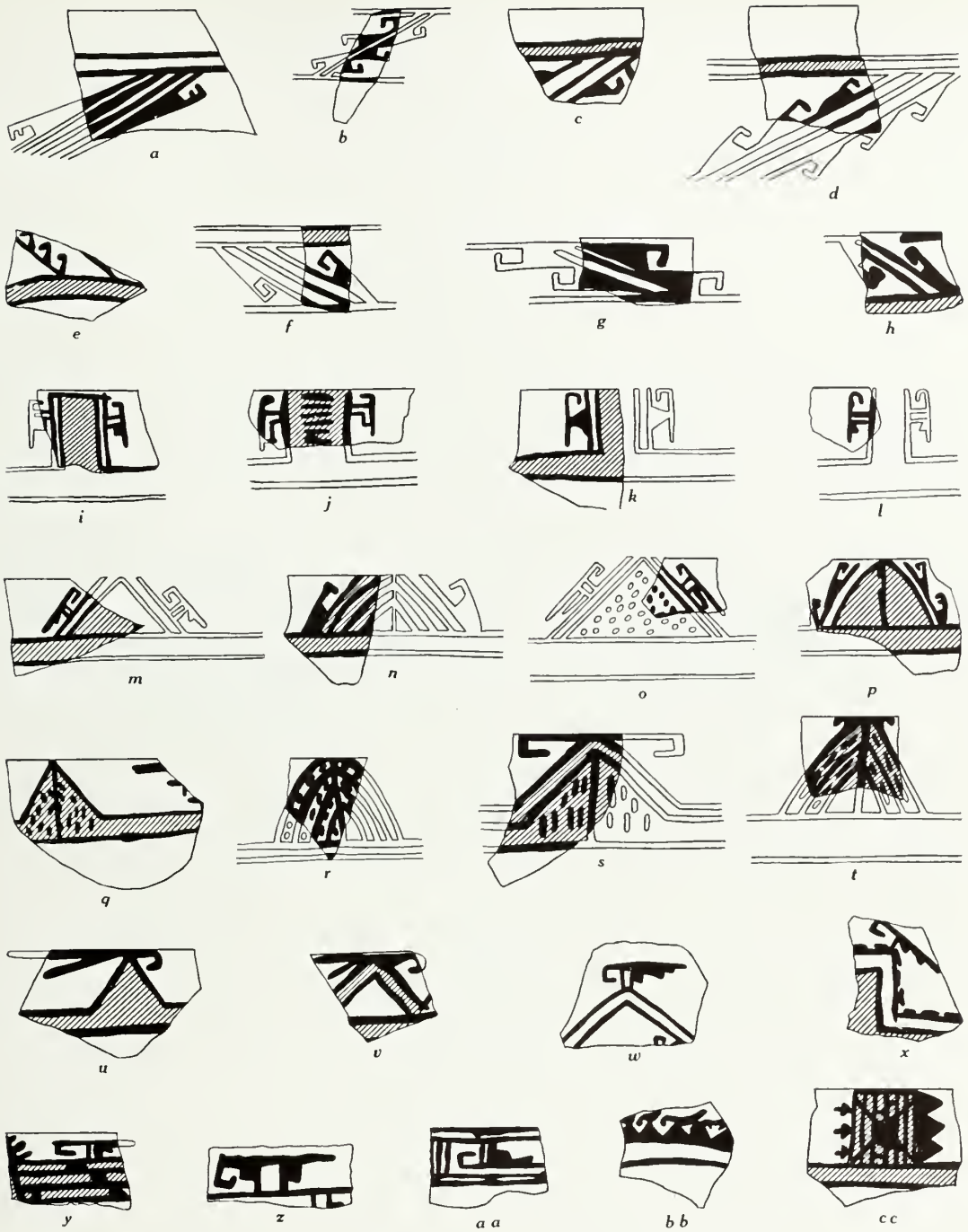


Fig. 157. Glaze IV. Typical elements of bowl decoration. *a-h:* Line-edger birdlets. *i-l:* Accessory birds on vertical protuberances from red base-stripe. *m*, *o:* Accessory birds on triangular protuberances from red base-stripe. *n*, *p:* Line-edger birdlets on triangle. *q-t:* Various triangular protuberances. *u*, *v*, *bb:* Triangle-apex birds. *w*, *x:* Accessory birds from jogged line all-over patterns. *y-aa:* Accessory birds. *cc:* Unusual treatment of the vertical protuberance. Drawn from sherds. Nos. *a-d*, *w*, *x*, *z*, *bb*, are from bowl interiors, the rest from exteriors. (1/4)

two sides of rectangular projections from encircling red stripes on bowl exteriors (*i*, *j*, *k*); on the sides of triangular projections (*m*, *o*); and on the corners of the jogged crossbar in all-over patterns (fig. 152).

Triangle-apex bird (fig. 157, *u*, *v*). We have only two examples, but they are so much alike, and so different from the other birds, that they seem to deserve segregation. Each of the figures is placed on the apex of a triangular projection from a red encircling stripe on a bowl exterior. There are no legs, the single horizontal line which forms the head and tail being applied directly to the supporting point. A second, shorter line extends obliquely downward from the base to the tail. The heads are curvilinear crooks. Some connection may be suspected between this form and the birds of the pendent triangle patterns of Glaze I (cf. figs. 20, 48).

Triangle-and-tail figure (figs. 153, *b*; 158, *a*). This is a strange figure, with vertical members suggestive of the Pajaritan bird (fig. 120), but differing from

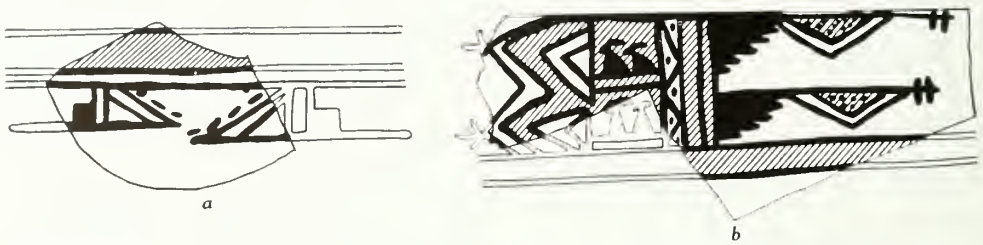


Fig. 158. Glaze IV. Triangle-and-tail figures. *a:* The commoner form (see also fig. 151, *b-d*) is characterized by vertical members and tail like those of the Pajaritan bird; the bird's head, however, is replaced by a triangle. *b:* Ornate figure apparently allied to the foregoing. (1/4)

the bird in that, instead of head and tail, it possesses two unlike lateral parts, one triangular and one terraced, each of which can be duplicated among the tails of the various sorts of Glaze IV birds. The figures appear on bowl interiors and upon the bodies of ollas. A very elaborate ornament (fig. 158, *b*) from the exterior of a bowl has obvious affinities to the triangle-and-tail figure.

Keys. Aside from its use in the large red decorations on bowl exteriors and olla necks, which are described below, the key plays a much less important role in Glaze IV than in the earlier Glazes. The opposed stalked keys with base, so abundant in Glazes I to III, are absent.

BOWL RIM DECORATION

One would think that the broad, gently curving interior surface of the Glaze IV rim would have formed an ideal field for ornament. But, queerly enough, it was seldom so used. Study of a group of three hundred rim sherds shows that decoration is both rarer and simpler than in Glaze III. A true zigzag, or a zigzag so softened as

to amount to a festooned line, occurs in a little over 10% of these sherds, there are three or four cases of oblique dashes, and two occurrences of a crude approximation of the Glaze III rim-bird (see fig. 121). The lip of a single sherd is marked with a group of dots.

BOWL EXTERIOR DECORATION

The embellishment of the outside of Glaze IV bowls is varied and elaborate. We have a large amount of material, not only in the shape of complete vessels, but in the great quantities of sherds shipped to the laboratory. Sherds, indeed, are almost as useful as unbroken pieces for study of the exterior design of Glaze IV, because the figures, being relatively simple, are easy to restore from even small fragments. Furthermore, the exterior designs are placed high. They run practically to the lip and they are seldom so broad as to extend far below the thickened rim. The rim, in Glaze IV, is tall; it is also the strongest part of the vessel; rim fragments therefore tend to be larger than those from the thinner, more fragile body; they accordingly display very satisfactorily the ornament upon the outside of the bowl.

All Glaze IV bowls carry exterior decoration, normally in matte red with glaze borders. Some dark-colored pieces, upon whose surface red would not show, and a very few lighter ones, are designed in glaze alone. There are:

Double-ended keys	28
Birds	19
Bands	10
Capitans	4
Miscellaneous	5
	66

DOUBLE-ENDED KEYS

Double-ended keys (figs. 159, 160) are, I think, somewhat less common than in Glaze III. My doubt as to the relative frequency, in the two types, of this red exterior figure is due to the fact that upon the whole Glaze IV specimens there is a fairly high percentage of keys, while upon the sherds they are very much rarer. Here is a clear instance of the evils of selective collecting. In the field we undoubtedly saved every fragment that bore any recognizable part of a bird, a *capitan*, or any reasonably large section of a band; whereas we presumably discarded a great many pieces illustrating the less variable and therefore less interesting keys. A check-up of the unselected sherds from the tests throws little light on the problem, because the representation of any single type, such as Glaze IV, is not large; and the fragments that do occur, while suitable for study of rim form, color, glaze, and other technological features, are mostly too small to permit the confident identification of designs. There is appended a classification of the double-ended keys upon complete bowls:

Free-standing	10
Right angled	9
Oblique	1
Interlocked	18
	28

It will be noted that one form of the double-ended key seen in Glaze III, i.e., the oblique type on base-stripe (fig. 123, *f-h*) is missing; and that the free-standing oblique type (fig. 123, *a-d*), which is fairly common in Glaze III, is here represented by but one specimen (fig. 159, *a*). Single keys on a base-stripe (fig. 124, *g*, *h*) are also absent.

Free-standing, right angled (fig. 159, *b-g*). The figure at *b* has two keys facing each other on opposite sides of a rectangular projection rising from their common stalk. Such a projection is seen in various other Glaze IV exterior designs. It usually is flanked by two small birds (fig. 157, *i-l*). The five remaining figures (fig. 159, *c-g*) are of the commoner variety with stalk bent twice at right angles to bring the keys into opposition. There is no whole bowl with figures of the four-bend variety of Glaze III (fig. 122, *d*), although the sherds prove that it does occur. The keys themselves, both on the whole vessels and on the sherds, are usually two-stepped, as were those of Glaze III. A change from earlier canons, however, is seen in the tendency to elaborate the figures by the addition, to the vertical member between the bends, of two small birds in glaze (fig. 159, *f*, *g*) or a pair of glaze keys without stalks (*e*) which bear resemblance to certain bird tails (cf. fig. 165, *d*). Further elaboration appears in figure 159, *g*, whose keys have glaze steps and whose ends are ticked after the fashion of many bird heads (cf. fig. 166, *a-d*).

Free-standing, oblique (fig. 159, *a*). This early form is evidently very rare in Glaze IV. I can find no example on any of the sherds. The single bowl which bears it is nevertheless surely identifiable as Glaze IV, although its rather low rim and the rough swabbing of the slip upon the lower part of the exterior serve to place it well down in the Glaze IV series. The interior pattern (fig. 147, *a*) is typically Glaze IV.

Interlocked (fig. 160). The most abundant of the red double-ended keys are of this sort. I can see no difference between them and their Glaze III prototypes, save in an apparently consistent lengthening of the terminal member of the key. The tendency toward elaboration by small added details in glaze, that appeared in the free-standing right-angled variety, is less in evidence (but see the tail-like unstalked keys upon the vertical members of *i*).

Jogged bar. For understanding of this figure recourse must be had to the drawings (figs. 159, *h*, *i*; 161). It consists of a long red bar bent twice at right angles, as is the connecting element of the double-ended keys. But there are no key terminations. The sides, but apparently not the ends, of the red bar are margined by glaze lines; and other glaze lines are drawn over the red, parallel to the margins. Small keys are placed on the horizontal parts of the bar in two cases (figs. 159, *h*; 161, *b*), birds in another (fig. 161, *a*); and in the somewhat similar, but not red, example shown in figure 159, *i*, there are two birds upon an adjacent triangle. The jogged bar

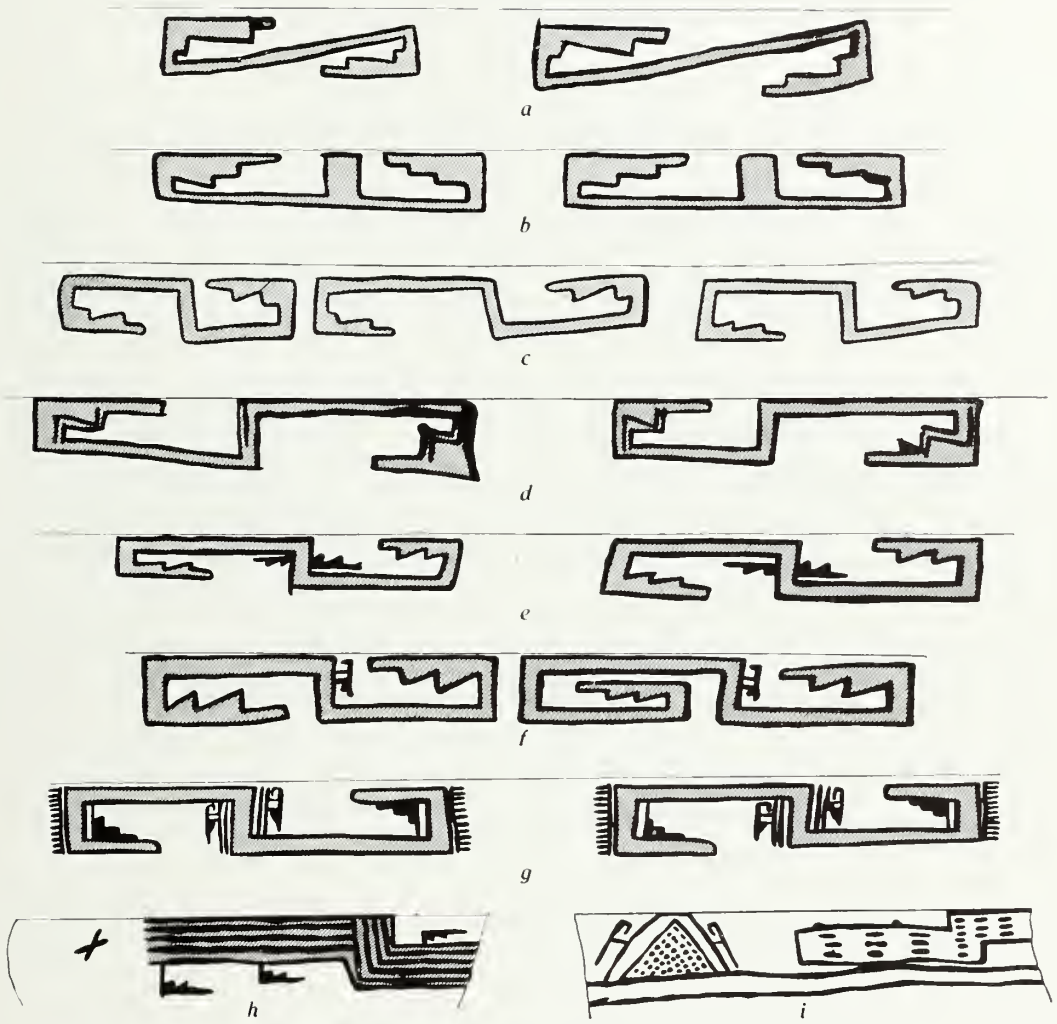


Fig. 159. Glaze IV. Double-ended keys from bowl exteriors. *a:* The rare oblique type. *b-g:* Right-angled type. *h*, *i:* Jogged bar figures which may be allied to the double-ended keys. For interior decoration of *a*, see fig. 147, *a;* of *d*, fig. 151, *c;* of *e*, fig. 151, *e;* of *f*, fig. 148, *h;* of *g*, fig. 153, *h*. Interiors of *b*, *c*, *h*, *i* not reproduced. (1/8)

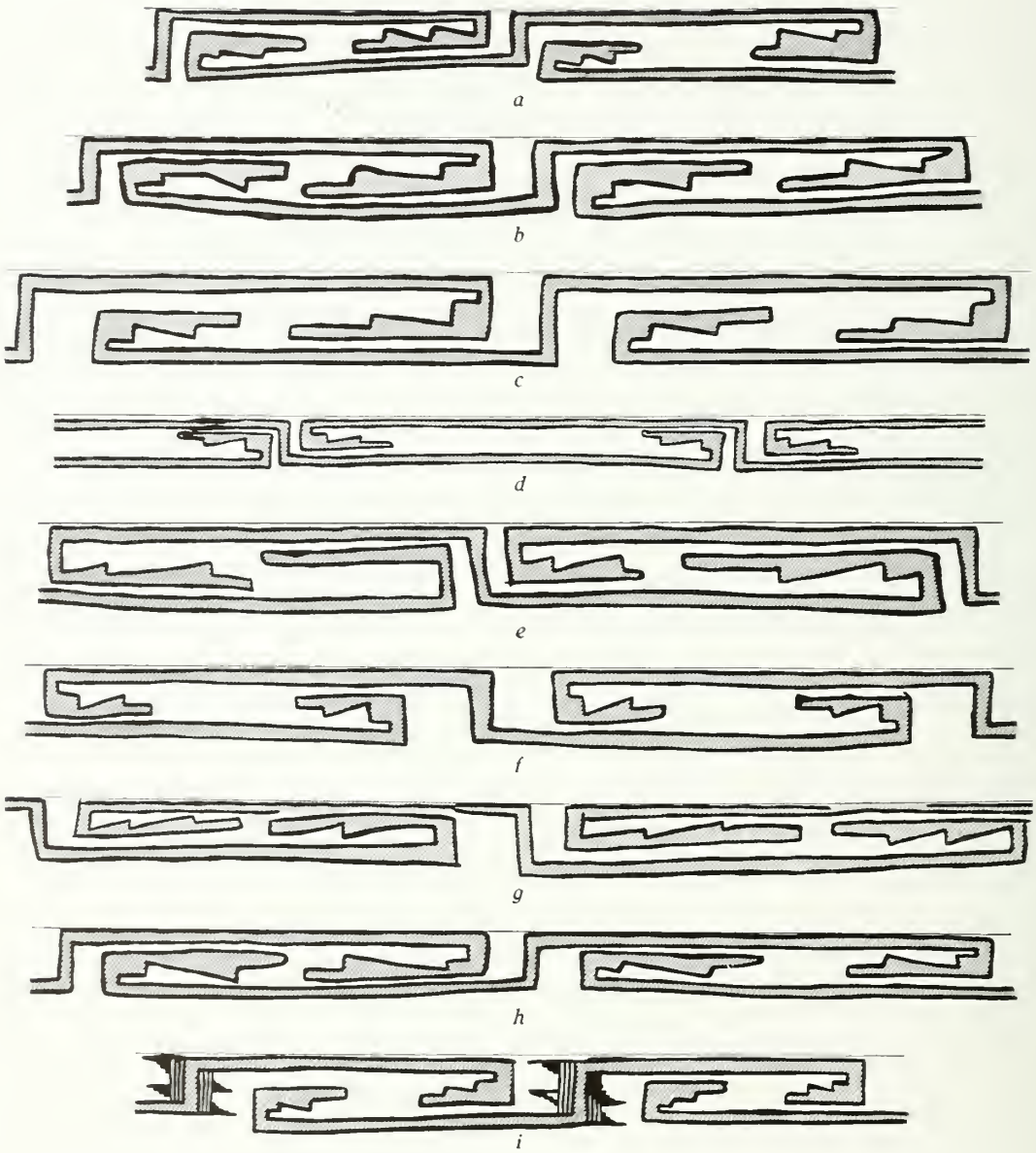


Fig. 160. Glaze IV. Glaze-bordered red double key decorations from bowl exteriors, interlocking type. For interior decoration of *a*, see fig. 154, *a*; of *b*, fig. 148, *c*; of *c*, fig. 152, *d*; of *d*, fig. 147, *c*; of *e*, fig. 154, *e*; of *f*, fig. 152, *g*; of *g*, fig. 154, *g*; of *h*, fig. 147, *e*; of *i*, fig. 151, *a*. (1/8)

is not common, but its few appearances are so much alike as to make it seem probable that our specimens are not "sports." There are resemblances (right-angled bends, red body-color) to the jogged band of bowl interiors (cf. fig. 152) and to the strange figure illustrated in figure 172, *c*.

BIRDS

In Glaze III the large red bird is less than half as common, as a decoration for bowl exteriors, as the double-ended key (see tabulation, p. 142); in Glaze IV it is about two-thirds as common as the key (p. 187). These comparisons are based on the whole specimens. According to the Glaze IV sherds, avian forms are relatively even more abundant; but, as was said above, selective collecting doubtless tended unduly to swell the representation, among the fragments saved, of these interesting

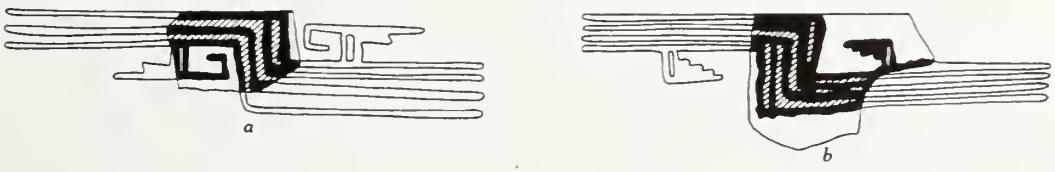


Fig. 161. Glaze IV. Bowl sherds bearing on their exteriors parts of the jogged bar figure. For a more complete specimen, see fig. 159, *h*. (1/4)

and attractive ornaments. The increase in use of birds is not, however, accompanied by very radical changes in the figures themselves, the Glaze IV examples being apparently all directly derived from Glaze III prototypes.[1]

Birds red throughout
Birds with red forepart
Birds with spotted body

BIRDS RED THROUGHOUT (fig. 162). As in Glaze III, the whole figure is red, outlined, of course, with glaze. There is a great falling off in naturalism: the bird with cocked-up tail (fig. 126) disappears entirely; the triangular bodied bird with curve-crook head (fig. 127, *a-d*) is extremely rare, only one or two sherds somewhat doubtfully indicating its occurrence. The Glaze IV red birds are not always placed upon an encircling red base-stripe, as they invariably were in Glaze III; they often attach themselves in pairs to opposite ends of segments of base-stripes (fig. 162, *e-g*). The older three-bird arrangement gives place to twos and fours. The figures, instead of sometimes facing left, sometimes right, almost invariably head in the latter direction. The figures are strongly geometric: the heads are rectilinear crooks, in

[1] Birds forming parts of exterior band patterns, being closely similar to those of interior bands, have been described with the latter (p. 183); for small birds on triangular and rectangular projections and upon lines, see p. 184 and fig. 157.

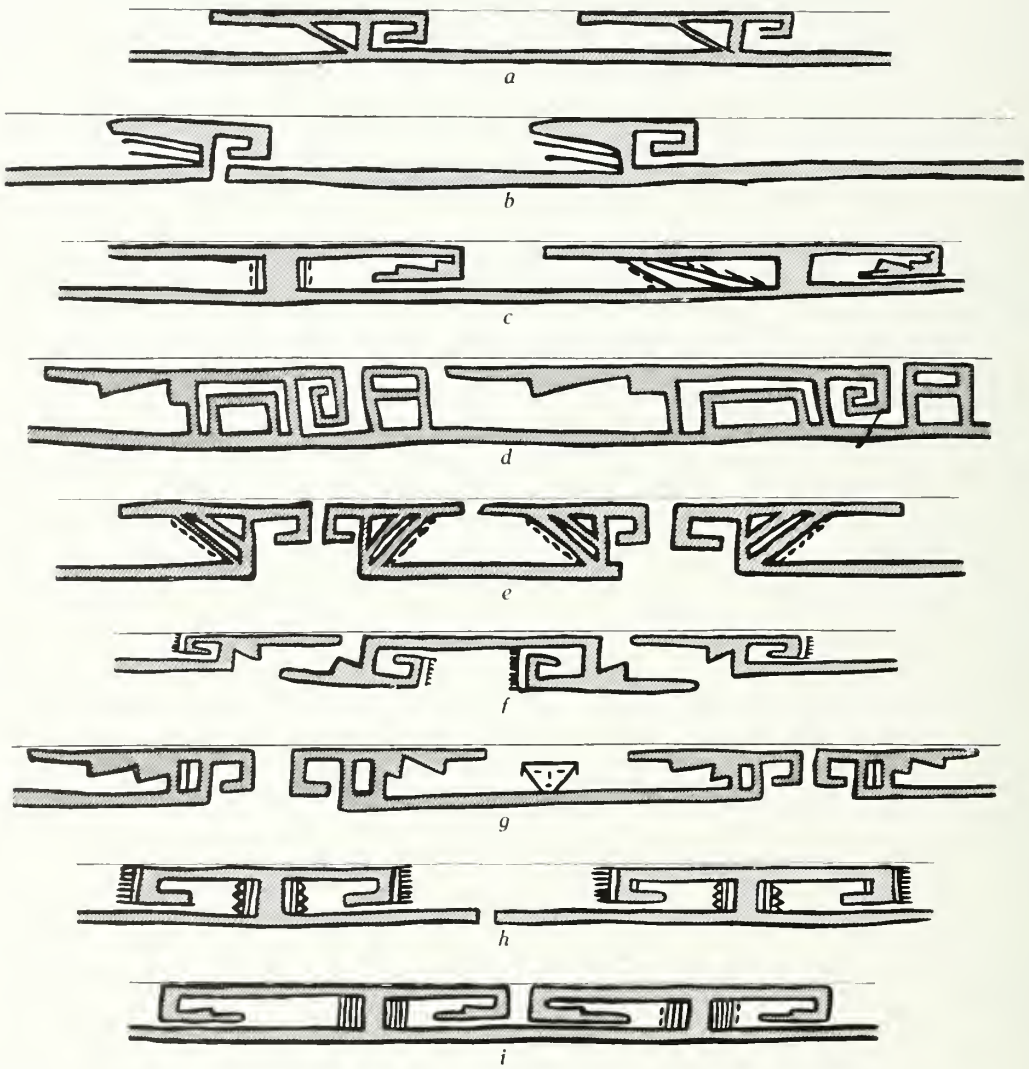


Fig. 162. Glaze IV. Glaze-bordered red decorations from bowl exteriors, birds red throughout. At *h* and *i* are figures with both avian and double key attributes. For interior decoration of *a*, see fig. 153, *b*; of *b*, fig. 151, *g*; of *c*, fig. 147, *i*; of *d*, fig. 154, *h*; of *e*, fig. 147, *f*; of *f*, fig. 153, *a*; of *g*, fig. 151, *d*; of *h*, fig. 154, *b*; of *i*, fig. 152, *f*. (1/8)

one instance a key (fig. 162, *c*). The tails are often terraced in the key manner (*d*, *f*, *g*). There is a tendency toward elaboration by added details in glaze (*c*, *e*, *f*), the ticking of the heads of *f* being evidently a transference from the bird with red forepart, which is regularly so treated (cf. figs. 163, *a*, *c*, *d*). Further examples of the mixing of styles are seen in figure 162, *h*, *i*. The figures in these patterns are obviously allied to the double-ended key, but they also possess certain avian attributes (ticked heads of *h*, "leg bars" of *h* and *i*).

Birds with red forepart (fig. 163). This group, examples of which make their first appearance in the later stages of Glaze III (fig. 129), reaches full development in Glaze IV. Normally two birds are placed upon a red base-stripe with wide exit space. Set well apart and facing to the right, they may be the sole ornament of the bowl's exterior (fig. 163, *a*, *b*, *c*); often, however, they are separated by triangular (*d*) or, more rarely, rectangular (*e*) protuberances arising from the base-stripe (the sherds provide many specimens, particularly of the triangular form—fig. 157, *m-p*). Birds with red forepart are sometimes alternated with other figures (fig. 163, *f*, *g*). The only instance in the collection of a free-standing bird with red forepart is seen at *i;* this, however, is obviously the result of a grafting of bird features upon the basic framework of a double-ended key.

The birds themselves, as the illustrations show, have a solid red forepart, continuing the red of the base-line. The body rises vertically, is bent at right angles to form the neck and is again bent twice to produce the rectilinear head. Paralleling the body there are usually a few close-set vertical lines; these may be both in front of the body and behind it (fig. 163, *a*, *d*), but are most often grouped behind the body in sets of two to four or five. If in front they are occasionally embellished with small X-markings (*d*). The tail (in glaze alone) abuts the rear group of vertical lines or, less commonly, is attached directly to the glaze border of the vertical red body. It is a highly variable element. The series of tails presented in figures 164, 165 makes clear the great number of results achieved. The upper member always continues the horizontal line of the neck. In a majority of cases there is more than one member, a second, a third and sometimes a fourth lying below and parallel to the upper one; they may be straight lines, triangles, attenuated keys, or combinations of such devices. A generally triangular effect is, however, generally produced by a decrease downward in the length of each member, the uppermost being always the longest; terraced blocking between line-members often accentuates this triangularity (fig. 164, *a*, *d*); an actual triangle is sometimes painted across the bases of line-members (*p*, *s*); triangular areas (*b*, *e*) or sets of oblique lines (*c*, *f*, etc.) commonly support, so to speak, the horizontal members. Tail-members almost invariably terminate in lines, which are marked, near their ends, by one or, more often, two short cross-lines. The rectilinear crook-head (fig. 166) is much more uniformly treated. It may be unadorned (*e*), but in most cases its vertical front is fringed by a series of six to nine ticks set directly upon the glaze border (*a*) or upon a short glaze line running parallel to it (*b-d*).

Birds with spotted body (figs. 167, 168). Birds of this category differ more widely from Glaze III forms than do the birds red throughout and those with red forepart. I nevertheless believe that they have prototypes in Glaze III; the point,

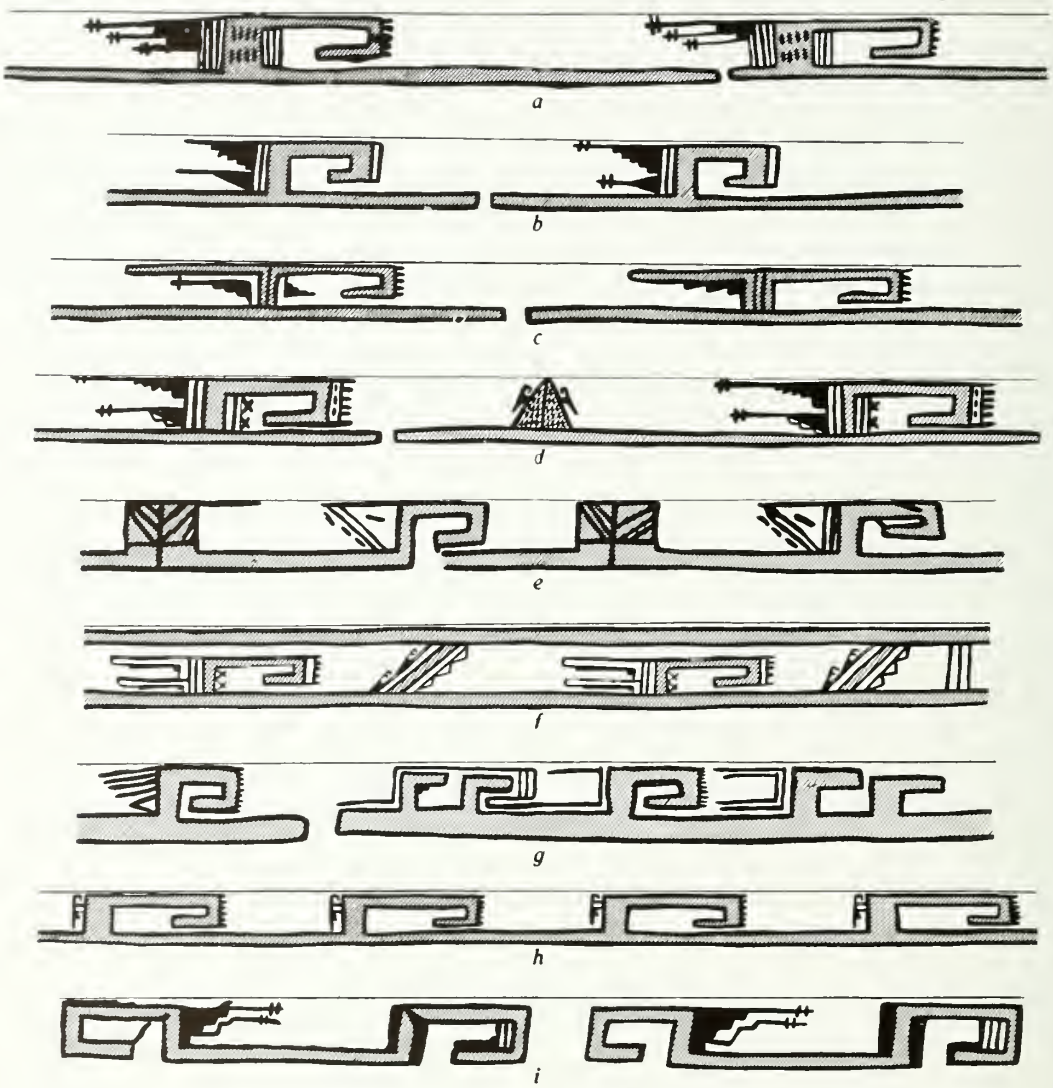


Fig. 163. Glaze IV. Glaze-bordered red decorations from bowl exteriors, birds with red forepart and allied motifs. For interior decoration of *a*, see fig. 153, *g*; of *b*, fig. 153, *e*; of *c*, fig. 151, *f*; of *d*, fig. 153, *c*; of *e*, fig. 148, *e*; of *f*, fig. 154, *d*; of *g*, fig. 154, *f*; of *i*, fig. 152, *h*. Interior of *h* not reproduced. (1/8)

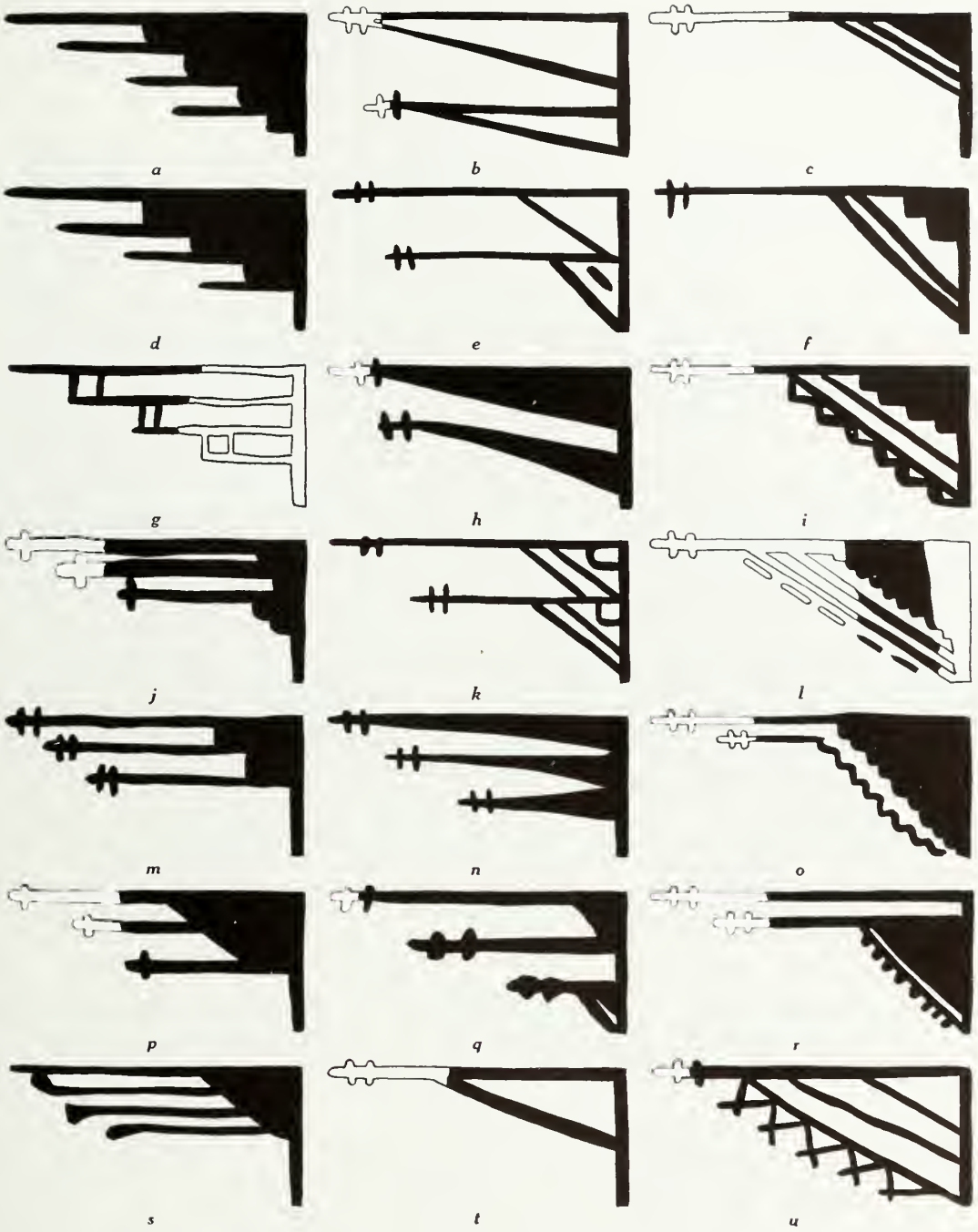


Fig. 164. Glaze IV. Tails of birds with red forepart from bowl exteriors. Drawn from sherds. The copies are accurate, but the figures have been brought to uniform size. Missing portions restored in outline.

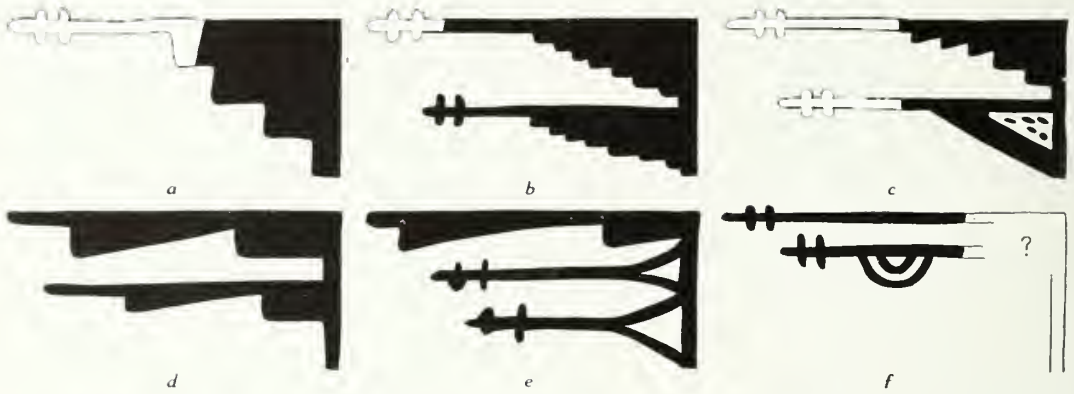


Fig. 165. Glaze IV. Tails of birds with red forepart from bowl exteriors. Drawn from sherds. The copies are accurate, but the figures have been brought to uniform size.

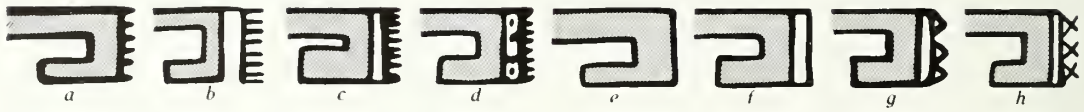


Fig. 166. Glaze IV. Heads of birds with red forepart from bowl exteriors. Not to scale.

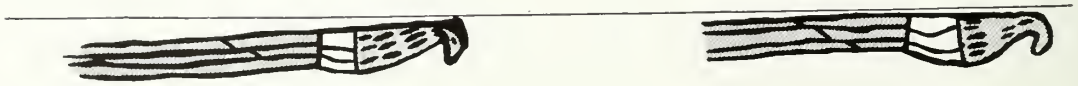


Fig. 167. Glaze IV. Birds with spotted body from the exterior of a bowl. These were the only complete specimens recovered; more typical examples restored from sherds are illustrated in fig. 168. For interior decoration of the bowl, see fig. 152, *e*. (1/6)

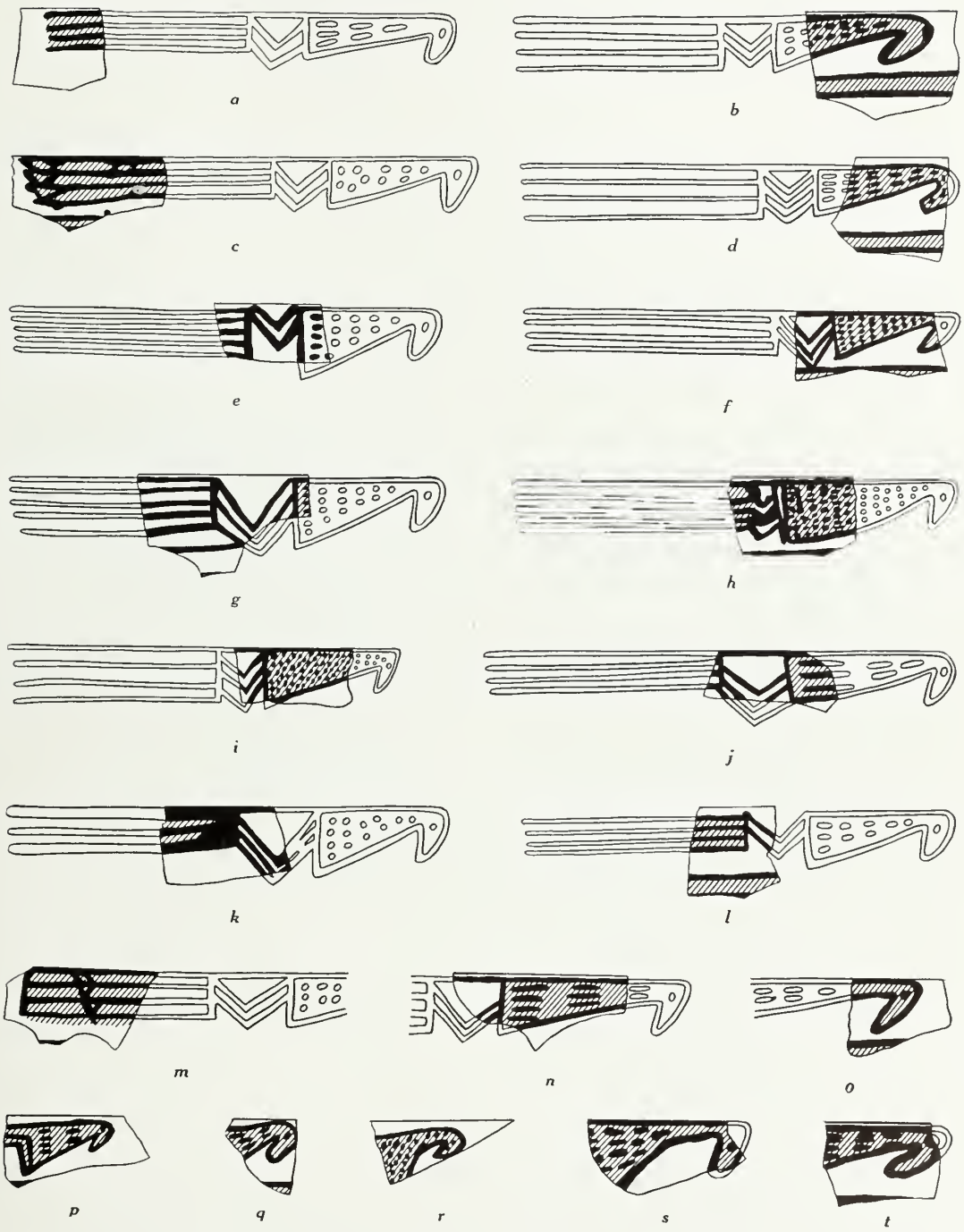


Fig. 168. Glaze IV. Birds with spotted body from bowl exteriors. This drawing illustrates the possibilities of design reconstruction from fragmentary material. (1/4)

however, can more intelligently be made after description of the very fragmentary material.

The figures in question are long, ungainly, straggling things, with an ugly break between body and tail. Data as to number per pot are unsatisfactory, but from the fact that our one complete specimen (fig. 167) has a pair, from the obviously great length of the figures, and on the analogy of the dual presentation of other Glaze IV birds, it seems likely that two habitually were used. They lie immediately below the edge of the bowl and close above or touching, a red stripe comparable to the base-stripe of the former categories. The body is a right triangle (see fig. 168), drawn with its next-to-longest side horizontal to and closely paralleling the bowl's edge, its short side vertical and its hypothenuse oblique. The head comes from the apex formed by the convergence of hypothenuse and horizontal side, the tail is attached to the short vertical side. Body and head are red. The body is more or less closely sprinkled with round dots (fig. 168, *b*, *f*, *h*, *i*) or marked with short dashes in vertical groups (*d*, *e*, *j*, *n*); a single dot in the head usually represents the eye, although there are cases in which the body dots continue along the neck and extend into the head (*d*). The head itself is curvilinear, its outward and lower aspects always so, its inner side usually nearly straight, thus producing a pointed beak; seldom does the head attain the full rounded recurve of the Glaze II and III crook-heads.

The tail, as has been said, attaches to the vertical end of the body. It consists of two to four or five (usually four) parallel lines, which angle downward, return chevron-like up and continue horizontally (and seemingly for a considerable distance) to the rear (fig. 167). The angle formed by the dip and rise of the lines may be open at the top (fig. 168, *e*, *g*). Very often, however, it is closed by a single line joining the upper line of the body to the topmost member of the horizontal extension of the tail (*f*, *h*, *i*, etc.). Doubt as to the length of the tail lines and as to the nature of their termination is due to lack of complete birds. Our one perfect specimen (fig. 167) has a tail about twice as long as its body. Its horizontal part is red; it is embellished near the middle by short diagonals, and the lines end without the little cross-marks so characteristic of the tails of birds with red forepart. The sherds illustrated in figure 168, *a*, *c*, *m*, probably bear the terminations of tails, but one cannot be sure. Two of them are red, and *h*, which shows the beginning of an undoubted tail, is similarly treated; the lines of *m* are cut by a diagonal and its ends are joined by a vertical line.

I believe the bird with spotted body to be derived from that variety of the all-red, triangular-bodied Glaze III bird, which has the curve-crook head (fig. 127, *a-d*). The bodies of both are triangular, the heads of both are curvilinear, the eye-dot sometimes occurs in the Glaze III birds. In one Glaze III example there is a pair of dashes in the body (fig. 127, *b*, right-hand figure). The tail of many of the Glaze IV birds with spotted body is red and therefore in the older tradition. The use of glaze over red, as exemplified by the dots, is a normal Glaze IV trait, frequently seen in the all-over patterns and in the exterior *capitans*. It is, however, quite possible that this peculiar bird was an out-and-out invention, which achieved popularity and was slavishly copied. If such were the case, no intermediate steps would be expected.

Or again, the transition, if such it was, may have taken place at some other pueblo and the developed form have been introduced at Pecos.

CAPITAN

This is without question the same symbol as the interior *capitan* (figs. 153, 155). On bowl exteriors there are always two units. They lie parallel to and close below the edge of the rim and almost invariably point to the right. The body of the figure is a long rectangle, its rear termination plain (fig. 169, *d*), ticked (*a*), or set with small triangles (*b*); in one case (*c*) it is furnished with a sort of keystone-shaped tail. At

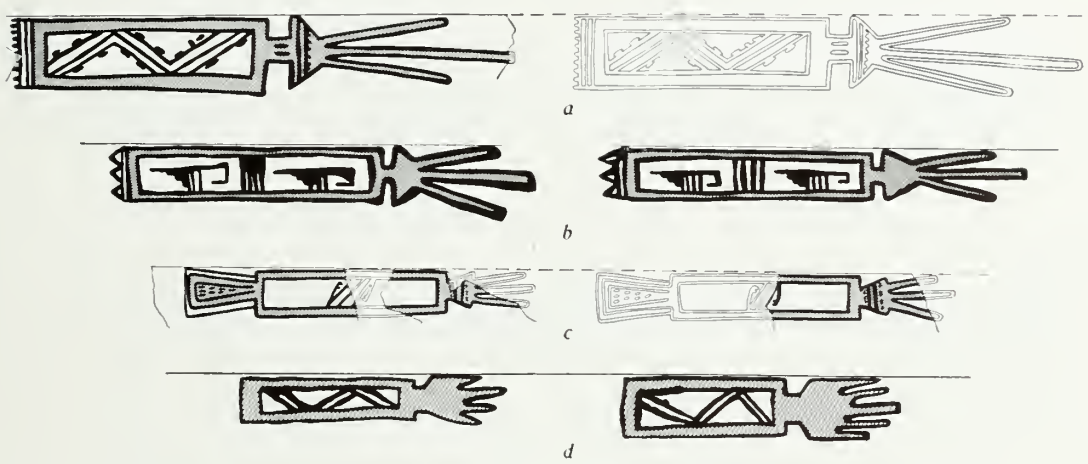


Fig. 169. Glaze IV. *Capitans* from bowl exteriors. The example at *d* is atypical in that it has five, instead of the customary three, projections from the "head." For interior decoration of *b*, see fig. 147, *h;* of *c*, fig. 152, *a;* of *d*, fig. 153, *d*. Interior of *a* not reproduced. (*Ca.* 1/6)

the forward end there is usually a short neck, which expands into a triangular head provided with three long appendages (in one badly-drawn specimen (*d*) there are four and five appendages). The apex of the triangular head may point either toward or away from the neck. In the former case the three appendages grow from the straight line of its outward side (fig. 170, *a*, *c*, *d*, etc.); in the latter the base is toward the neck and the appendages arise from the apex (fig. 169, *a*, *b*). The appendages themselves are square- or round-ended; the middle one continues the general horizontal line of the whole figure, the two outer ones fan slightly away from it, although the three are sometimes practically parallel (fig. 170, *d*).

The periphery of the rectangular body, the neck, the head, and the appendages is red. Upon the neck and head there is usually a certain amount of superadded glaze ornament: lines across the neck (fig. 170, *a*); lines (figs. 169, *a*, *c;* 170, *g*), zig-

zags (fig. 170, *b*), dots (fig. 170, *d*) in the head; or an arrangement of three dashes so placed in the head as to produce simple but unmistakable representations of the eyes and mouth of a human face (fig. 170, *a*, *c*, *e*, *f*). The nose appears but once (*e*).

The inner part of the body constitutes an elongated rectangular field, outlined by red. It is, naturally enough, treated as a band by paneling it (fig. 169, *b*), or by handling it as a single panel (*a*, *c*, *d*). Familiar band elements: single birds (*b*), birdlets on oblique lines (*c*), zigzags (*a*, *d*), embellish such panels.

BANDS

The illustration (fig. 171, *a-g*) presents seven of the ten bands which appear as exterior decorations upon bowls. It will be observed that they follow closely the

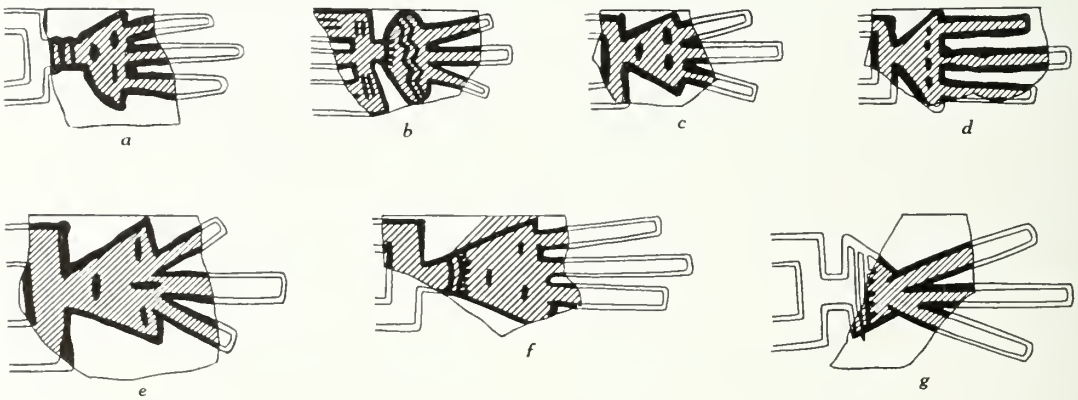


Fig. 170. Glaze IV. *Capitan* heads from bowl exteriors. The depiction of human features (as at *a*, *c*, *e*, *f*) is rare in Glaze IV; in Glaze V it becomes habitual (cf. fig. 203). (1/4)

canons of interior bands, but that the upper and lower framing lines are more often omitted (*a*, *d*, *f*). Paneling is of the type found in interior bands; and the bird, zigzag, and oblique line elements used as fillers are analogous to those of interior panels.

MISCELLANEOUS EXTERIOR PATTERNS

Six specimens fail to fit clearly into any of the above groups. Two of them (fig. 171, *h*, *i*) belong to what, on the evidence of the sherds, seems to have been a not uncommon class. Drawn at wide intervals upon a glaze base-line or paired base-lines are sets of short vertical lines, upon the outermost of which there are small accessory birds, their heads pointing toward the rim. There are sherds which indicate that the glaze base-lines were often replaced by a glaze-bordered red base-stripe, the red color mounting between the short vertical lines (fig. 157, *i-k*). Small birds occupy, in such cases, the same relative positions as in the plain glaze patterns. Still other sherds bear parts of an apparently very similar arrangement of red triangles upon a red base-stripe (fig. 157, *m-p*). Two little birds, in such cases, adorn

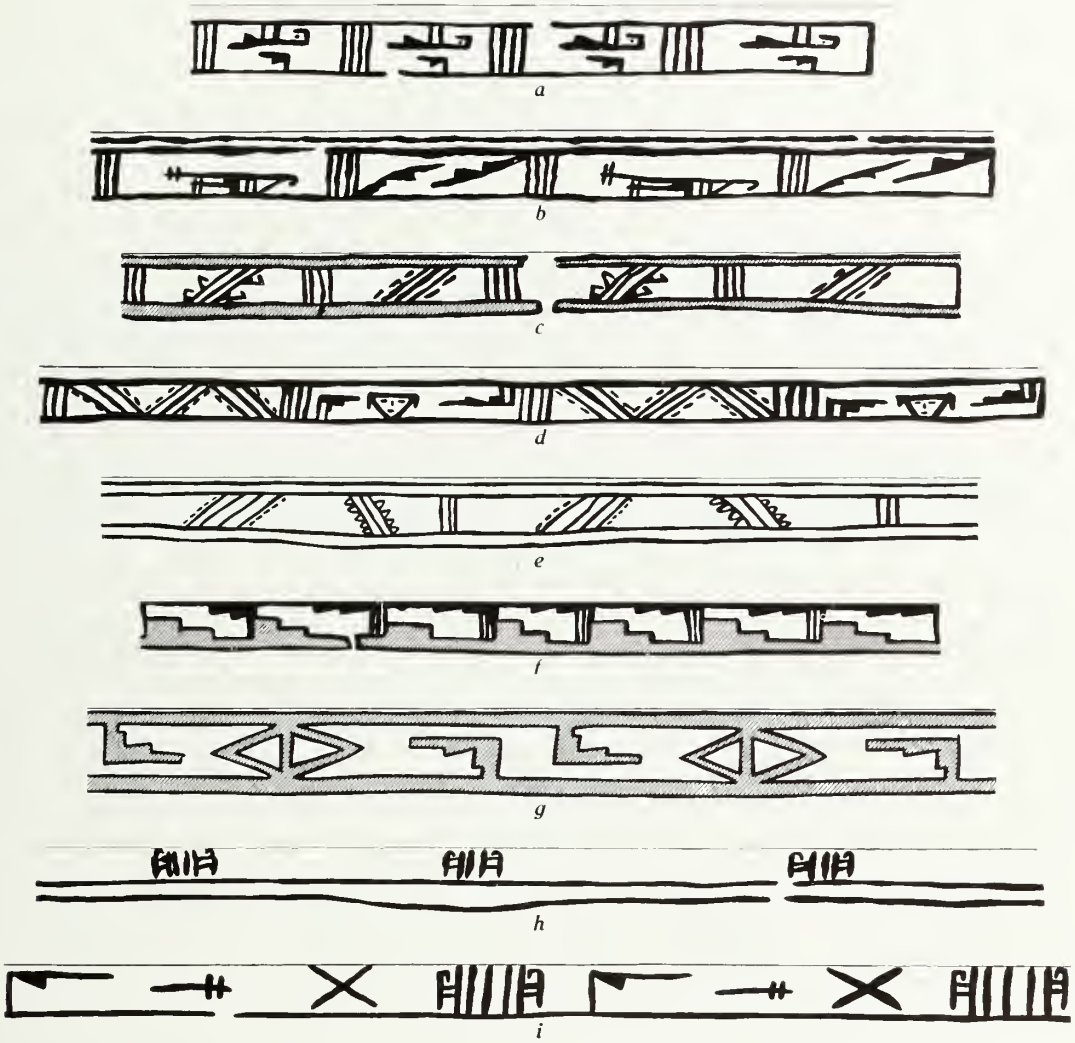


Fig. 171. Glaze IV. Band and band-like patterns from bowl exteriors. For interior decoration of *b*, see fig. 148, *a;* of *c*, fig. 147, *g;* of *d*, fig. 147, *d;* of *e*, fig. 148, *d;* of *f*, fig. 154, *c;* of *g*, fig. 148, *b;* of *h*, fig. 148, *f*. (1/8)

the sides of the triangle. The triangular protuberance with accessory birds is also often found between large bird figures (fig. 163, *d*).

Of the four remaining miscellaneous band patterns (fig. 172) that at *a* has fourteen triangles above a red base-stripe. The two hand figures (*b*) seem to be an adaptation to the elongated field of a bowl exterior of the all-over rendition of this motif developed for the round field of the interior (fig. 154, *f*, *g*). What, in figure 172,

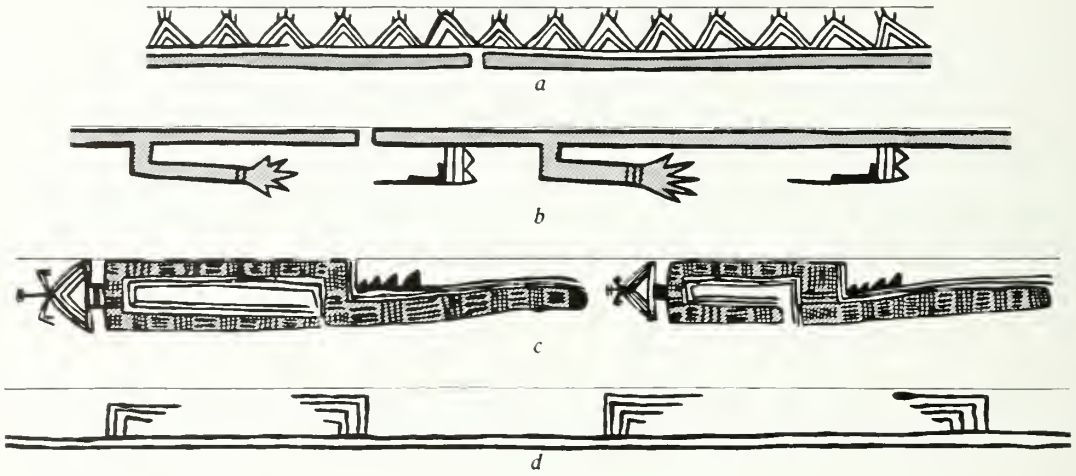


Fig. 172. Glaze IV. Unusual patterns from bowl exteriors. For interior of *a*, see fig. 152, *c*; of *b*, fig. 151, *b*; of *c*, fig. 147, *b*. Interior of *d* not reproduced. (1/8)

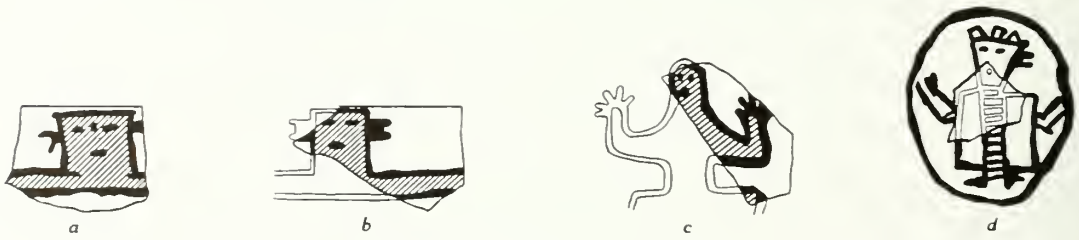


Fig. 173. Glaze IV. Anthropomorphic representations. *a*, *b*: From bowl exteriors. *c*, *d*: From interior bottoms of bowls. (1/4)

c, was symbolized by the two long figures is problematical. Their heads and necks recall those of *capitans*, but the three red appendages of that figure are replaced by short glaze lines. The bodies suggest the stalks of double-ended keys; there are analogies to the jogged bar figure (cf. figs. 159, *h*, *i*; 161, *a*). No sherd provides material for comparison. The simple pattern at *d* is unique.

Two illustrations drawn from sherds, show other unusual exterior patterns: the fragments in figure 173, *a*, *b* bear human heads, shaped and placed like the

rectangular protuberances that usually bear pairs of accessory birds (fig. 157, *i-l*); those in figure 174 are decorated in the exceedingly rare curvilinear manner.

OLLA DECORATION

Although there is general similarity in decoration between the interior of the bowl and the body of the olla; and between bowl exterior and olla neck, the correspondence is not as close as in Glazes II and III.

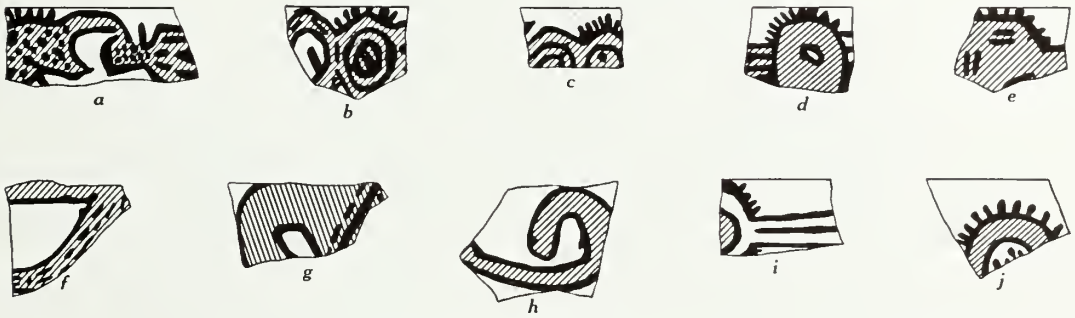


Fig. 174. Glaze IV. Unusual or aberrant figures. *a-c:* Sherds from the exterior of a single bowl, bearing parts of an apparently continuous device. *d, e, i, j:* Circular figures with ticked peripherae; perhaps allied to the Glaze III "sunburst" pattern (see fig. 131); from bowl exteriors. *f-h:* Fragments of curvilinear all-over patterns; bowl interiors. (1/4)

BODY

This zone is always treated as a band. The lower framing line encircles the vessel exactly at the point of greatest diameter, overlying and usually hiding the junction between the red slip of the base and the lighter slip of the upper body. It is normally broken by an exit space (fig. 175, *b*). An upper framer may (fig. 176, *b, e*) or may not (fig. 175, *a-c*) be present. The banding lines lie close within the framers. When the upper framer is absent, the upper banding line is placed just below the red neck-stripe.

The band is sometimes, but by no means always, paneled (this, it will be remembered, was also true of bands upon bowl interiors). Our data are distressingly meagre, but it appears that paneling, when present, was produced, as in bowls, by series of vertical lines. The most common panel fillers are zigzags (fig. 176, *b, d, e*), sets of oblique lines with embellishments of dashes or line-edge birds (fig. 176, *g, i, k*), and large ornate birds with red forepart (fig. 175, *a, b*). I have found only one certainly identifiable *capitan* on an olla (fig. 177, *a*), although the rectangular object in figure 176, *h* may perhaps be the termination of another. Parts of two figures, which are not duplicated on the bowls, appear in figure 177, *b, c*. The restoration is based on similar decorations, also on ollas, from Tyuonyi and Ojo Caliente. In a

former publication I called this the "jog figure" because of the two angular protuberances on the long shafts.[1]

NECK

As in Glaze III, the material for study of the olla neck is relatively abundant. The sherds, however, are for the most part so small that while many of the elements can be identified with certainty, their arrangement is often a matter of doubt. A red,

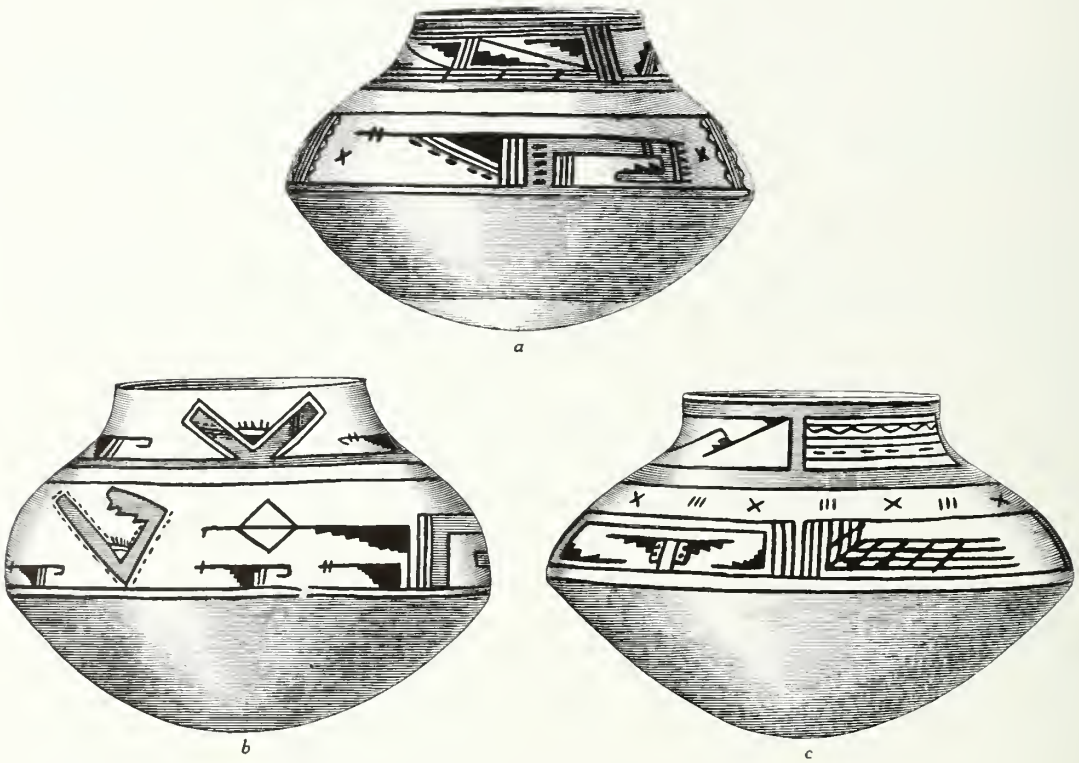


Fig. 175. Glaze IV. Ollas. *a:* Typical specimen of the best period; the unfortunately very fragmentary original is one of the finest pieces of glaze-decorated pottery found at Pecos. The bird panel on the body is repeated three times. *b:* Typical except that the body band is unpaneled. *c:* Probably early (vertical neck; slung key—a Glaze III element—in left-hand panel of neck pattern). (1/6)

glaze-bordered stripe always encircles the vessel at, or just below, the rather vaguely defined junction between neck and body (fig. 175). It usually, perhaps invariably, has a broad exit space. Almost always there is a second stripe directly below the lip; this sometimes has an exit space, but because of the fact that such a break appears on very few of the sherds, it is probable that it was more often omitted. There are

[1] Kidder, 1915, p. 441, fig. 17.

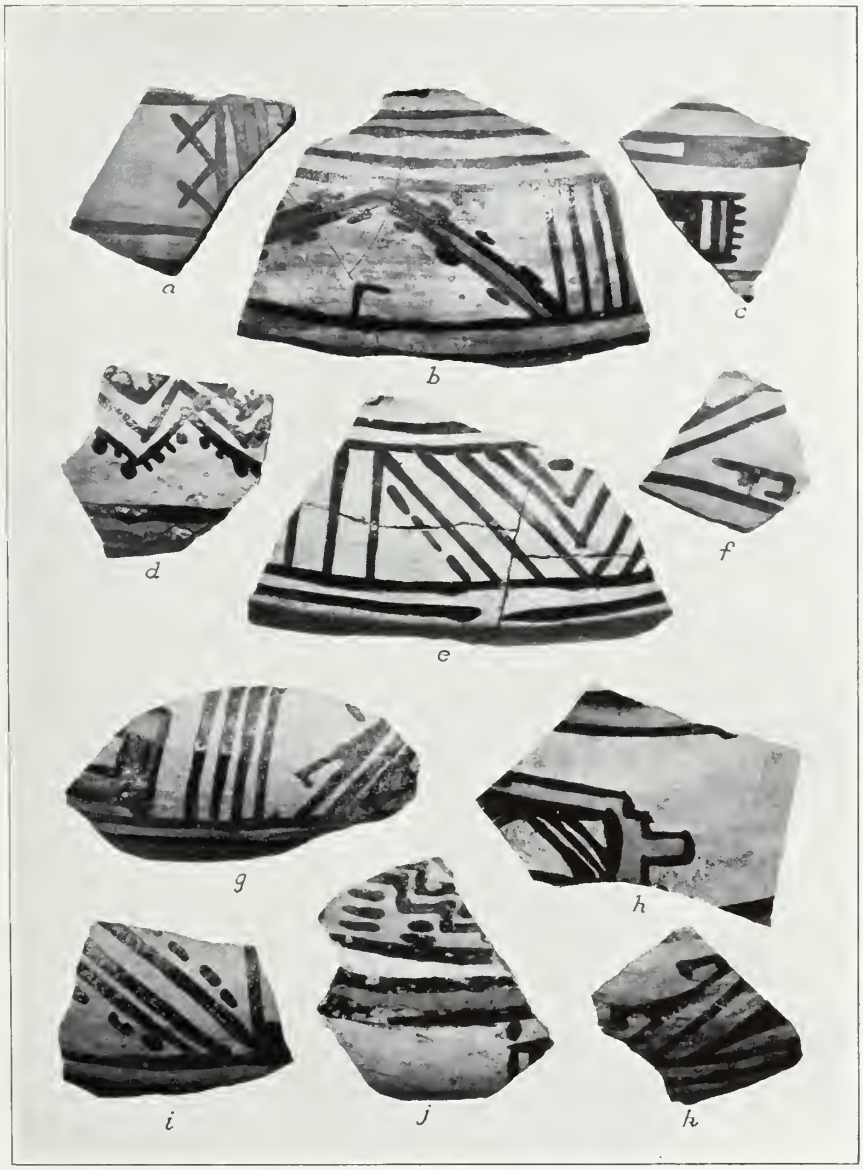


Fig. 176. Glaze IV. Sherds from the bodies of ollas. (Width of *b*, 6 inches)

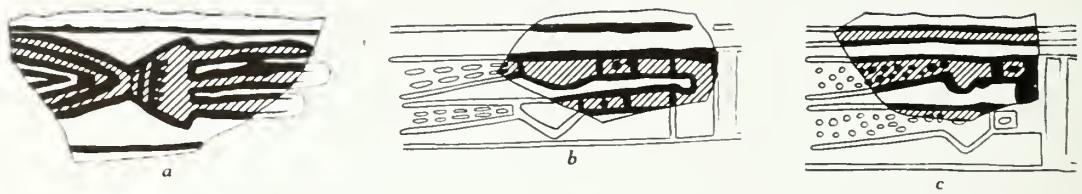


Fig. 177. Glaze IV. Olla body decorations. *a: Capitan*, the only case noted at Pecos of the use of this figure on an olla. *b, c:* A peculiar double figure only found on ollas—the restorations are made on the basis of better-preserved examples from other sites. (1/4)

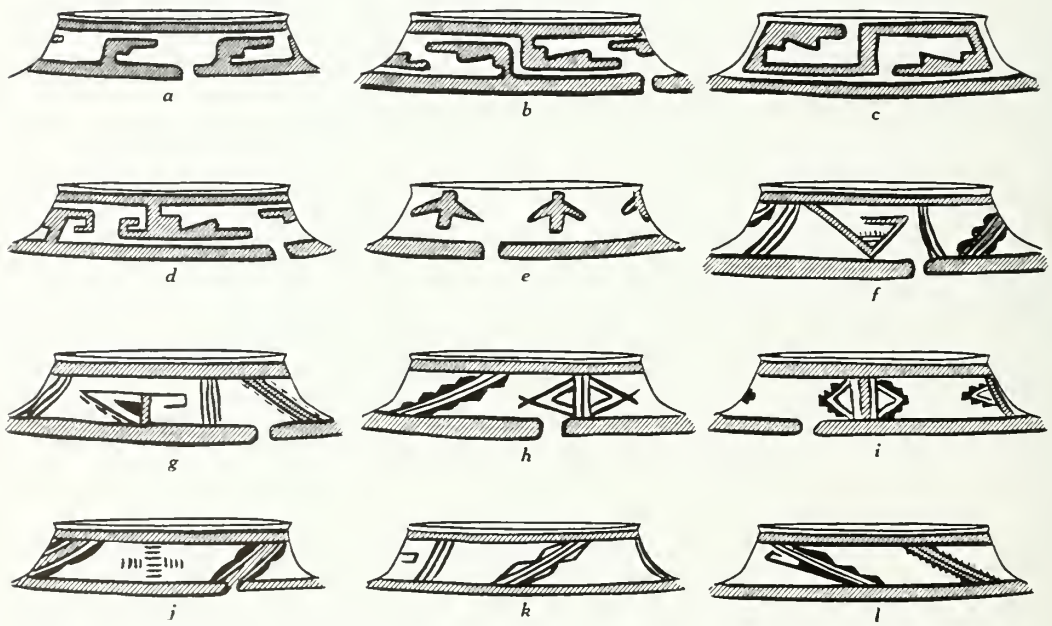


Fig. 178. Glaze IV. Olla necks restored from sherds. The very slightly differing shapes of the originals have, for convenience, been standardized. (*Ca.* 1/6)

specimens with no upper stripe (fig. 178, *c*, *e*), but these are much rarer than in Glaze III (cf. fig. 136). As a rule, then, the neck pattern is a true band, the red stripes serving as banding lines. It is embellished in various ways.

KEYS. Red keys are among the commonest of neck decorations. The double-ended figure is, however, of much less importance than in Glaze III; its oblique variant, indeed, is only found upon two or three sherds (fig. 179, *c*). The right-angled type (figs. 178, *c*; 179, *a*) is apparently always used in pairs. It generally has no upper stripe. Most frequently seen are series of single keys, which rise from the lower stripe (fig. 178, *a*); or, coming from below and hanging from the upper stripe, face each other in opposed pairs (*b*).

BIRDS. The semi-naturalistic red bird, so much in evidence on Glaze III olla necks (cf. fig. 136, *j*, *k*), is not represented in the Glaze IV collection. There are two examples of red birds with terraced, key-like tails and rectangular heads (figs. 178, *d*; 179, *b*); and a single sherd bears figures which suggest a "spread-eagle" depiction (fig. 178, *e*). The bird with red forepart, often found on bowl exteriors and on olla bodies, is not represented. Pajaritan birds, however, often form part of panelled band patterns (figs. 178, *g*; 179, *j*). Line-edger birdlets and accessory birds will be mentioned below.

SETS OF OBLIQUE LINES. Even more abundant than key figures are groups of three or four parallel and closely set lines running obliquely between the upper and lower red stripes. They appear as elements of paneled bands, alternating with the Pajaritan bird (fig. 178, *g*, *k*) or the triangular crook (*f*); in unpaneled bands they alternate with the dash figure (*j*) or swallow-tail (*h*); often they form the sole ornament of the neck, but in such cases they are usually so embellished as to produce an alternating effect (*l*). Although the lines are occasionally plain, they are much more often elaborated by dashes, small triangles and line-edger birdlets like those used upon the oblique lines of bowl interiors (cf. fig. 156). Red pigment sometimes runs between the lines, adding richness to the pattern (fig. 178, *g*, *j*, *l*).

SETS OF VERTICAL LINES. These are groups of three to five or six lines drawn vertically and close together between the red stripes which delimit the neck band at top and bottom. The two outer lines of each set are ornamented with accessory birds (fig. 180, *b*, *e*), dashes (*c*), keys (*i*), small triangles (*d*, *f*, *g*), or larger triangles forming swallowtail figures (*f*, and fig. 178, *h*); accessory birds are also found on the points of such triangles (fig. 180, *h*). As in the oblique lines, red often appears between the vertical elements (fig. 180, *b-e*, *i*). The genesis of this type of decoration is problematical. It seems to have no prototype in Glaze III. The sets of lines are, of course, much like the multiple paneling lines of band patterns from bowls and olla bodies; some paneling bars on olla bodies are, indeed, elaborated in similar ways (see body band of olla in fig. 175, *a*). The figures sometimes actually serve to divide the neck band into sub-areas, containing other elements (fig. 178, *h*); but in other cases it seems probable, although the material is very fragmentary, that, repeated four times, they constitute the only decoration of the neck. The sets of lines with pairs of accessory birds should be compared with the short vertical protuberances with similar birds seen on bowl exteriors (fig. 157, *i-l*).

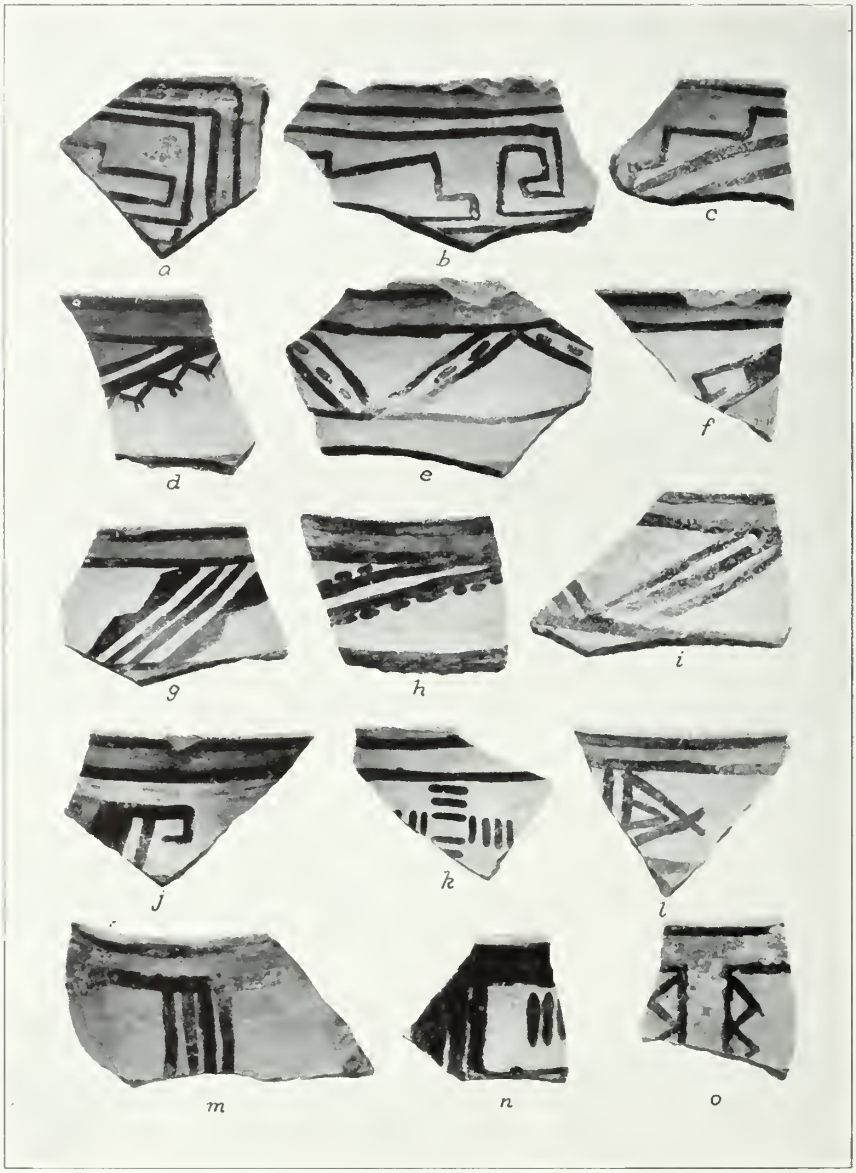


Fig. 179. Glaze IV. Sherds from the necks of ollas. (Width of *b* at rim, 3½ inches)

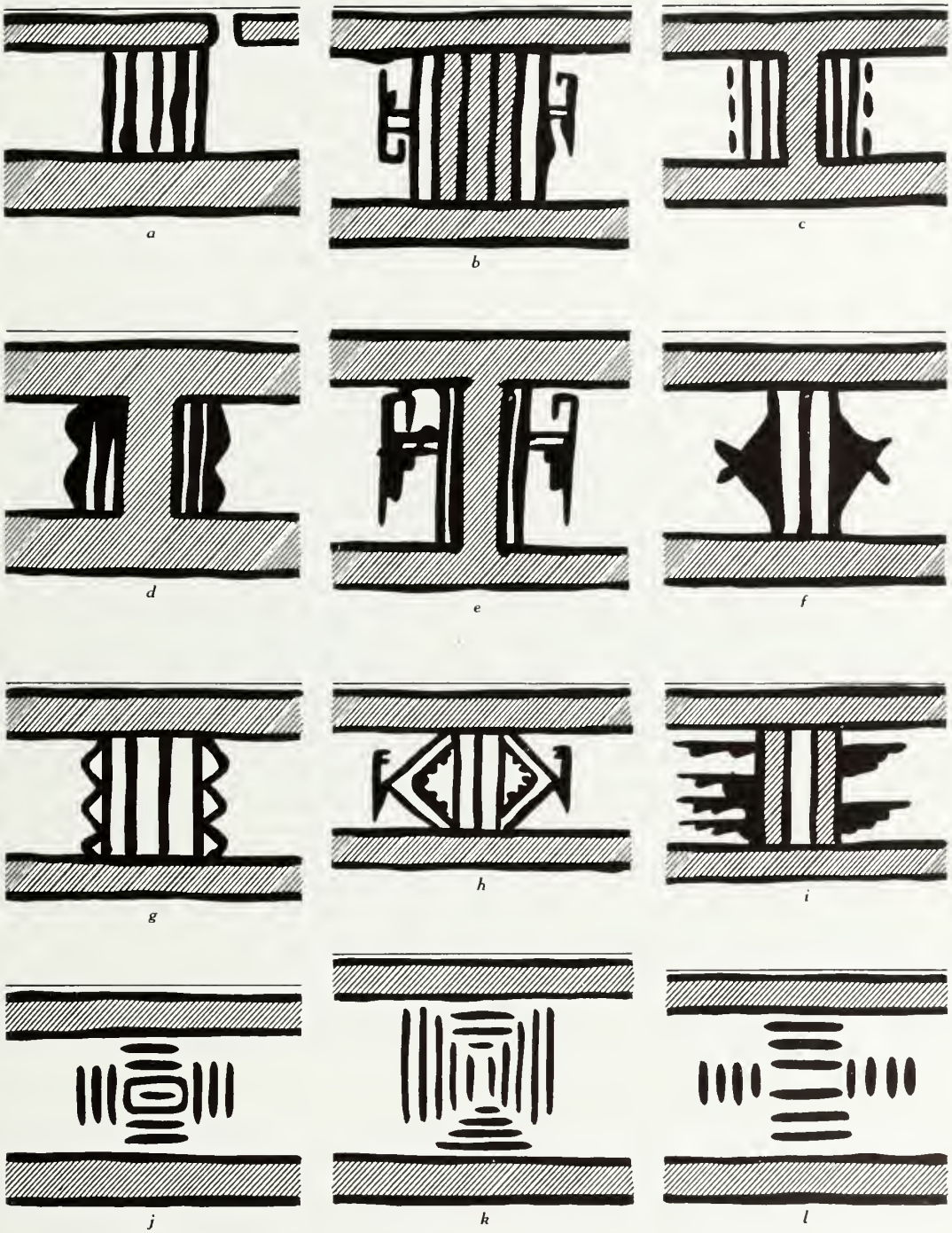


Fig. 180. Glaze IV. Olla neck decorations, typical examples based on vertical lines (*a-i*) and composed of series of dashes (*j-l*). (1/2)

Dash figures are composed of short lines so arranged as to form cross-like ornaments (figs. 179, *k*; 180, *j-l*). They are seemingly restricted to olla necks. I suspect that they were at times the sole embellishment of the field, though one sherd (fig. 178, *j*) clearly indicates that they might be alternated with oblique lines.

Bent line (figs. 178, *f*; 181). This peculiar figure occurs on three olla neck sherds. There is an example from the interior of a Glaze III bowl (fig. 116, *k*); it also occurs on Glaze IV bowls from the Pajarito Plateau.[1]

SHOULDERED BOWL DECORATION

There is, properly speaking, no interior decoration, although groups of six to eight or ten close-set ticks are usually found upon the beveled inner surface of the rim (fig. 102, *c*). The material being mostly fragmentary, it is not possible to gather satisfactory data as to the number of groups per bowl. Of eight whole specimens, two have no ticks, one has two groups, four have four, and one has five.

Fig. 181. Glaze IV. The bent line figure from olla necks. (1/4)

The upper part of the exterior is always decorated (fig. 102, *c*, *d*). This narrow zone between the point of greatest diameter and the edge of the rim is usually about 1¾ inches wide, never less than 1 inch, nor more than 2 inches. On its normally light-slipped surface are painted band patterns in glaze alone; red elements are apparently never present. The designs, save for the absence of red, cling to sound Glaze IV canons, although, because of the elongated shape of the field, there is exclusive adherence to the band; and, again from considerations of space, certain standard Glaze IV elements are used in new ways.

Naturally enough, so narrow a band very rarely possesses framing lines. There are, however, specimens with a single framer at the shoulder (fig. 183, *aa*) or just under the rim (fig. 182, *a*); and one or two sherds bear both upper and lower framers. The banding lines normally lie at the shoulder and immediately below the rim. They are often unbroken, but when the exit space appears it is most commonly seen in the upper line alone. Most bands are divided into two or four panels by sets of three or four vertical lines. Panel fillers are:

[1] Kidder, 1915, pl. XXII, 2.

Zigzags	31
Triangles with produced sides	3
Triangles with apex marks	2
Oblique lines with dots or dashes	6
Oblique lines with birdlets	3
Birdlets back-to-back	14
Birdlets, single series	5
Pajaritan birds	16
Indirectly opposed keys	2
	82[1]

Zigzags are the commonest single device. All are of the oblique type. They may be two- (figs. 182, *a*, *b;* 183, *c*), three- (fig. 183, *b*, *d*) or four-line (fig. 183, *e*); plain (figs. 182, *b;* 183, *a*, *b*, *e*) or dotted (figs. 182, *a;* 183, *c*, *d*). The number of points of the zigzag naturally depends on the length of the panel.

Triangles with produced sides. Small triangles, set in series along the upper or the lower banding line (never upon both), have their sides carried beyond the apex to form two little horn-like projections (fig. 183, *i*). Apparently six or seven units comprised the decoration of the panel.

Triangles with apex marks (fig. 183, *h*). Exactly like the foregoing, except that the two little projections are vertical, having been added to the apex of the triangle instead of being the result of producing its sides. This may seem an unnecessarily fine distinction, and the two figures should perhaps be grouped together. They are, however, structurally different, and there may have been a distinction between them in the mind of the potter, for in the sherd illustrated in figure 183, *n*, a series of triangles with produced sides, pendent from the upper banding line, faces a set of triangles with apex marks upon the lower banding line.

Oblique lines with dots or dashes. I have figured no example from a shouldered bowl, but the appearance of the same device upon the wider panels of standard bowls may be seen in figure 156, *a-e*.

Oblique lines with birdlets. This common decoration of the standard bowl is, perhaps because of the narrowness of the band, not much used on shouldered bowls. Three oblique lines cross the panel; on each of the two outer lines is a birdlet, one headed upward, one down (figs. 182, *d;* 183, *r*).

Birdlets back-to-back rank with zigzags and Pajaritan birds as standard decorations for Glaze IV shouldered bowls. The birdlets have triangular bodies and two-dash (fig. 183, *f*, *g*) or, more commonly, rectangular crook heads (*j-o*). They are painted in series, one set upon the lower banding line, one set upon the upper; the two series head in opposite directions, so that the units assume a back-to-back position, neatly filling the narrow zone. Birdlets of this type constitute a current or running pattern. They probably often extended uninterruptedly around a shouldered bowl to produce an unpaneled band, as they surely sometimes did in Glaze V (cf. fig. 216, *d*, *e*). We have, however, no positive evidence to this effect. There are,

[1] The frequency counts are taken from the general digging sherds which bear legible designs.

on the other hand, sherds which prove that back-to-back birdlets were used in panels, alternating with other elements (see fig. 183, *n*).

Birdlets, single series (fig. 183, *p*, *q*), are precisely like the foregoing but are drawn either on the lower (*p*) or upper banding line (*q*), without being balanced by a second set.

Pajaritan birds (fig. 183, *w-bb*) are common. Although naturally somewhat reduced in size, because of the narrowness of the decorative zone, they are otherwise identical with the Pajaritan birds from standard bowls (rectangular crook head, vertical bars, line or terraced tail).

Indirectly opposed keys (fig. 183, *t*, *u*) are rare. This device consists of a line running obliquely between the upper and lower banding lines; it is paralleled by the stalks of two small, two-step keys, which, by a single right-angle bend at the end of each stalk, are brought into indirect opposition (i.e., they are separated by the central oblique line and by their stalks).

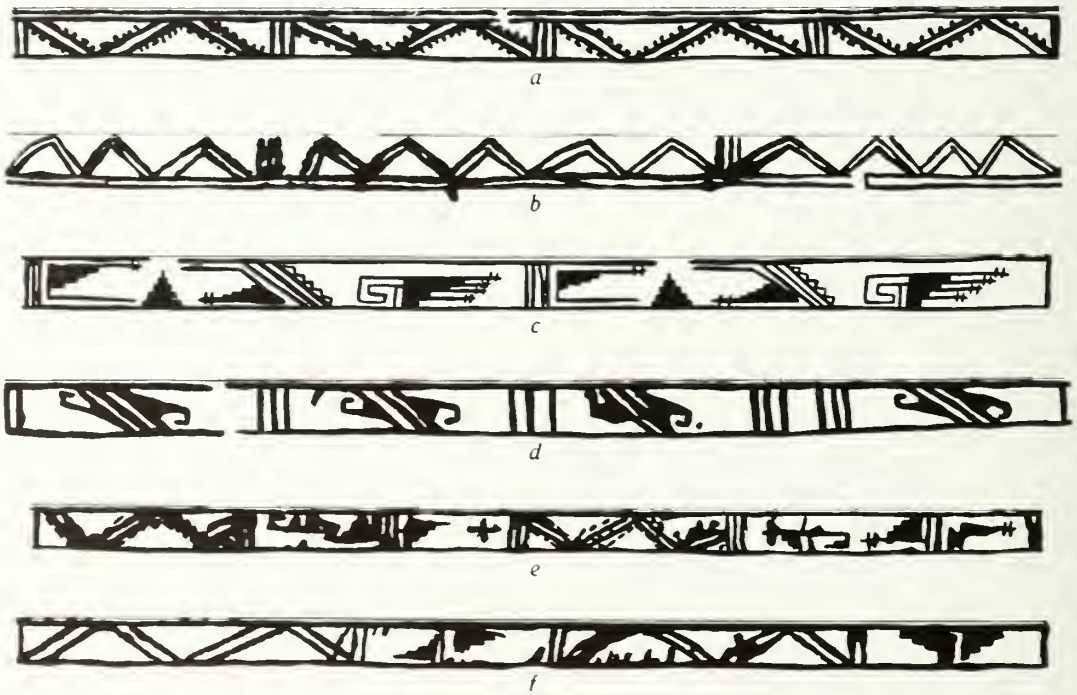


Fig. 182. Glaze IV. Bands from shouldered bowls. Paneling is the rule. The pattern at *b* is very unusual in that it has no upper banding line; that at *e* is marred by running of the Glaze much more seriously than is common in Glaze IV. Key figures (*f*) are very seldom seen in the decoration of Glaze IV shouldered bowls, although they are common in Glaze V (cf. fig. 214, *m*, *n*, *p-s*). (1/6)

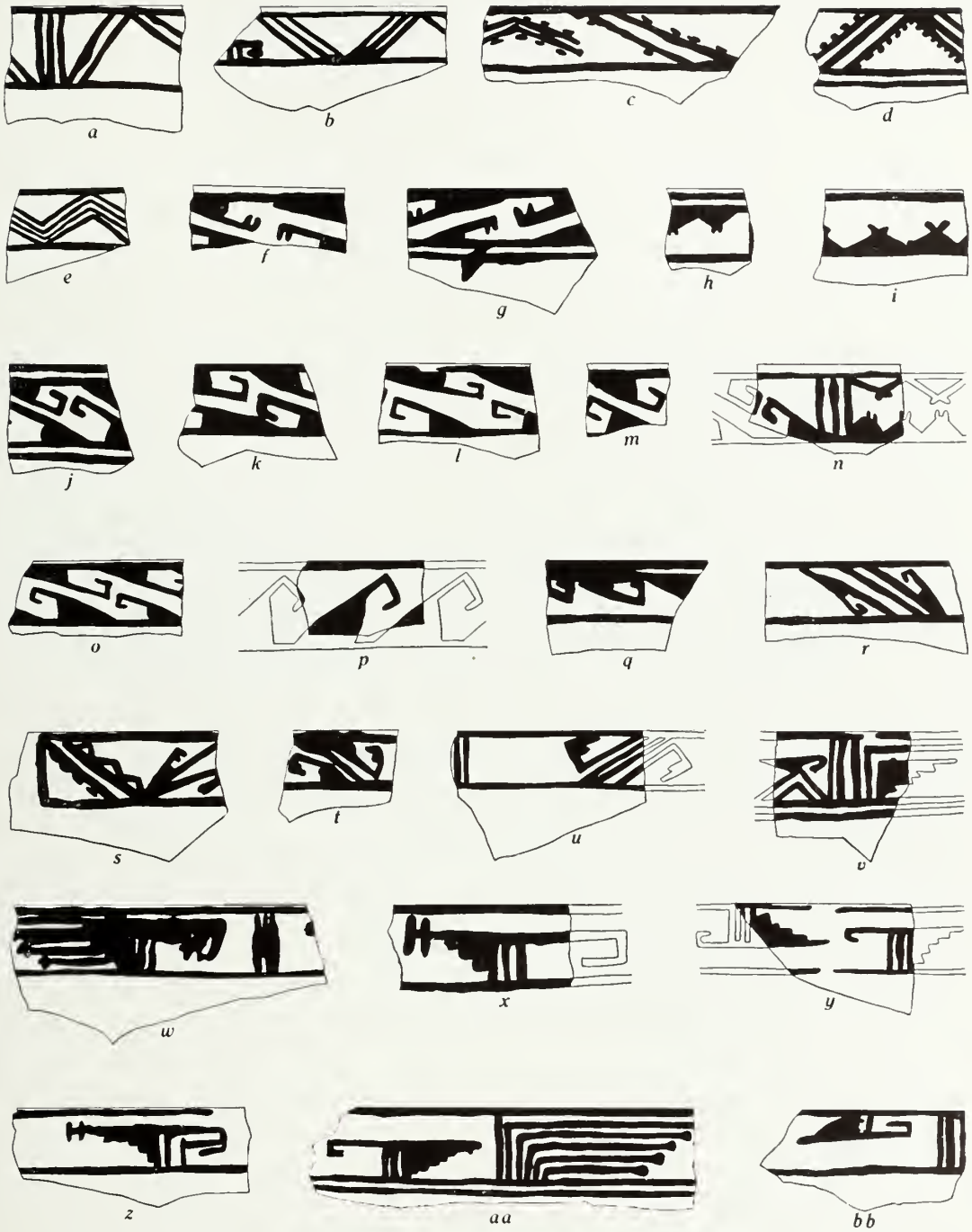


Fig. 183. Glaze IV. Shouldered bowl sherds illustrating elements of design. *a-e:* Zigzags. *f*, *g*, *j-m*, *o:* Birdlets back-to-back. *h:* Triangles with apex marks. *i:* Triangles with produced sides. *n:* Birdlets back-to-back (left panel), triangles with produced sides and triangles with apex marks (right panel). *p*, *q:* Birdlets in single series. *r*, *s:* Birdlets on oblique lines. *t*, *u:* Indirectly opposed keys. *v:* Triangle-apex bird and bird-tail (?) symbol. *w-bb:* Pajaritan birds. (1/3)

GLAZE V[1]

Glaze V is the light-slipped type which succeeds the dark-slipped Glaze IV and precedes the highly variable and degenerate Glaze VI, the last of the Glaze series. Description of Glaze V must be prefaced by the listing of three factors which set it apart from any of the types heretofore treated. In the first place, it seems to have had a longer life than any other Glaze. Secondly, it was the only type which certainly originated at Pecos and which had a local rather than a general distribution. Thirdly, the material for our study consists almost wholly of sherds, because Glaze V vessels were very seldom buried with the dead.

The statement that Glaze V originated at Pecos implies, of course, that its prototype was the local Glaze IV. This was indeed the case, as was proved by the presence, in several stratigraphic tests, of a horizon lying above rubbish with typical Glaze IV and below rubbish containing typical Glaze V, which carried a considerable number of obviously transitional sherds. A few bowls of the same sort were also recovered, but these, being from graves, are assigned to the transitional period upon artistic, rather than upon stratigraphic, evidence. Figures 143, *c*, *d*; 187, *a* illustrate such specimens.

GENERAL CHARACTERISTICS[2]

Glaze V, being light-colored, marks a return from the somber slips favored during Glaze IV to the more contrasty backgrounds in vogue from Glaze I Yellow to Glaze III. This is the most striking feature of the pottery under discussion. In color-scheme it resembles Glaze III: i.e., the painting is in matte red outlined with dark glaze upon light backgrounds. But the red elements are so greatly reduced in size and darkened in shade, and their glaze borders are so broad, that the general effect is much less glaringly polychrome. In spite, however, of the relative unimportance of red, it appears consistently both inside and outside of bowls and upon the necks and bodies of ollas.

From a clear, creamy white the slip varies toward the yellows or the grays. In color it is remarkably uniform, much more so than is the light slip of any other Pecos Glaze type. The red pigment of the designs, as has been said, averages darker than that of Glaze III and IV. The slip is a thick coat, readily distinguishable in section to the naked eye. It masks the dark paste so completely that there is very seldom any flushing through. It is, however, subject to wear and some pieces suffer in appearance from the scaling off of small flakes. Crackling is practically absent. Surface finish is, on the average, good; perhaps even better than in Glaze IV. A true polish, however, is never seen. Our few whole bowls are remarkably free from firing clouds; such blemishes of this sort as appear upon the sherds are a light gray, rather than the blue-gray or slate-gray of Glaze III firing clouds. Bowl interiors grayed by imperfect ventilation are very unusual.

[1] Glaze V belongs to Mera's Group E; it has been named by him "Pecos Glaze-polychrome."

[2] For Miss Shepard's technological description, see pp. 512-513.

It is in the glaze that the most striking contrast with earlier types is seen. Thick and with normally high luster, it runs and spreads to such an extent that designs are often completely destroyed. Where heavy, it is a rich dark brown, almost black; where thinner, greeny-brown, sometimes with bluish iridescence; and when, as often happened, little trickles separated themselves from the body of a design, they are yellowish-green to apple-green. The potters obviously took pleasure in the fine effects produced by heavy applications of this glaze; their lines grew broader and broader, niceties of design were abandoned in favor of bold, "blobby" figures, of which the uncontrollable runs were of quite as great decorative value as were the original lines. Many sherds show areas of several square inches of glaze and it is a wonder that some enterprising potter did not cover an entire vessel with the mixture and thus inaugurate the manufacture of vessels completely covered by glaze. It

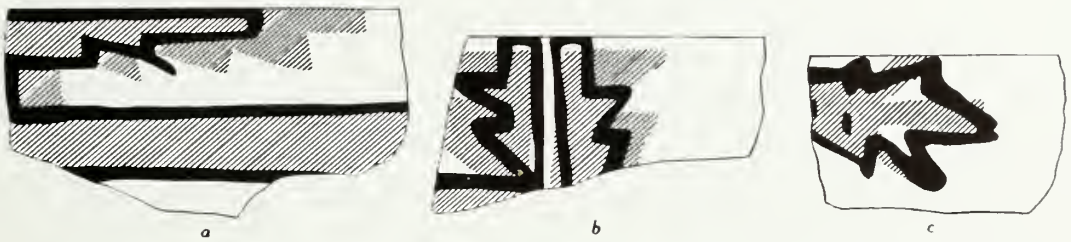


Fig. 184. Glaze V. Exteriors of bowl sherds showing the slipshod manner in which, during this period, the glaze bordering lines were often applied to red decorations. (1/2)

would have been of superlative beauty, for the finest examples of this glaze, particularly on the necks of middle Glaze V ollas, possess a depth of color and a velvety glossiness not surpassed by any glaze, ancient or modern, Western or Oriental, with which I am familiar. It is greatly to be hoped, although it is scarcely probable, that some of the splendid pieces which we now know only in the form of small sherds, will eventually be found complete, to prove to lovers of fine ceramics what these forgotten New Mexican potters could produce.

Examination of the Glaze V material shows that both bowls and ollas were fired in the inverted position. In the case of the earlier types, this was demonstrated by the restriction of fire-clouds to the exterior; in Glaze V it is equally clearly indicated by the fact that the glaze, upon melting, almost invariably ran toward the vessel's orifice. Very often, indeed, little streams reached the lip to gather and solidify there in the form of beads whose rounded form also shows that the vessel must have been so supported as to keep most of its rim free from contact with anything below.

The carelessness of Glaze V potters as regards accuracy of line-work in the application of the glaze is well brought out by their frequent failure, in painting borders, to follow the edges of the previously drawn red figures. The margining was always done in a more or less slapdash manner, the glaze often missing the red or straggling over it; extreme examples are illustrated in figure 184.

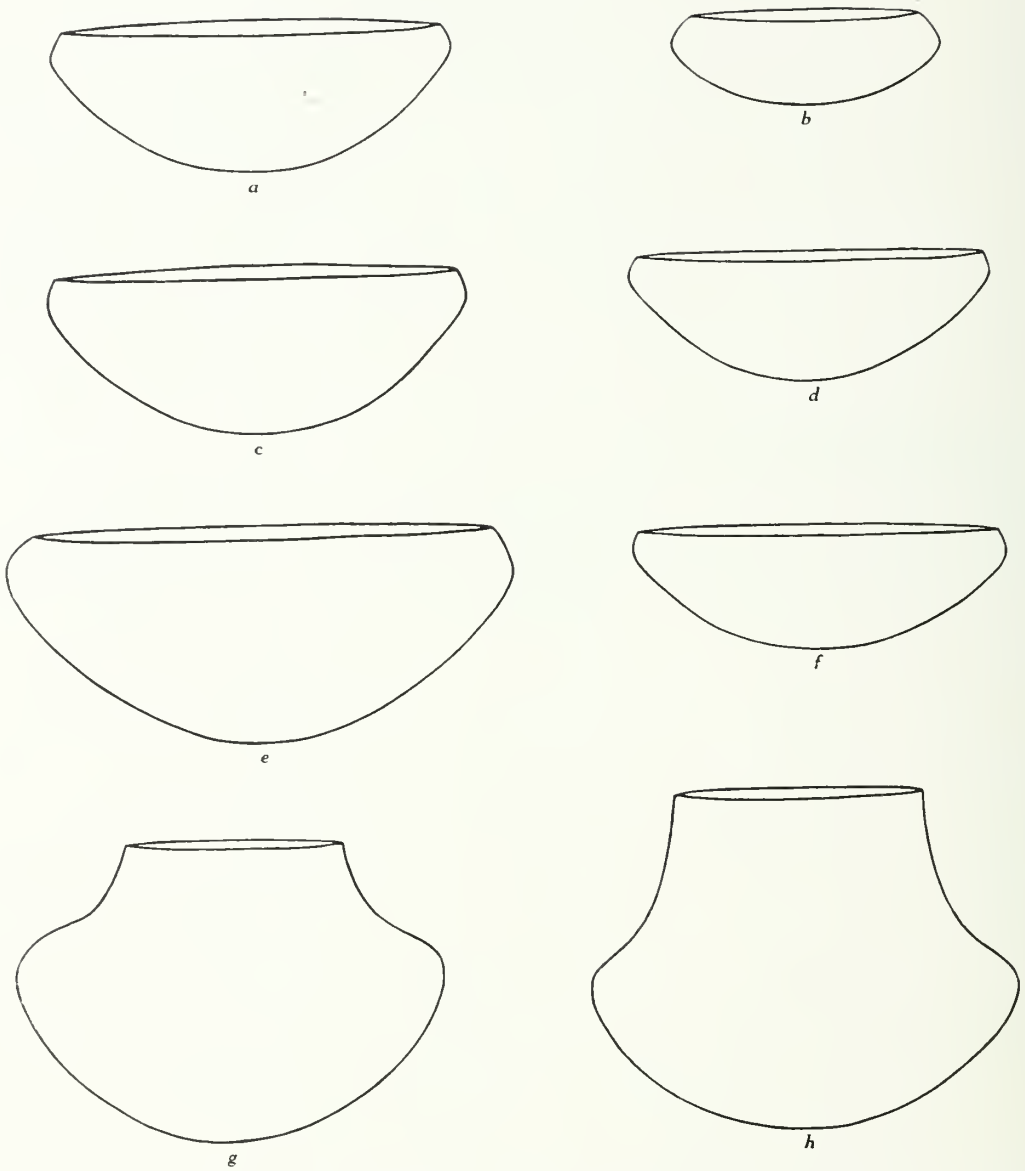


Fig. 185. Glaze V. Vessel shapes. *a-f:* Bowls. *g:* Early form of olla with low neck. *h:* Middle period olla with high neck. (1/6)

During the Glaze V period, red-slipped bowls (fig. 220, *a*) and ollas (fig. 226) with decoration in glaze-bordered white were somewhat more often made than in Glaze III or IV. In shape and decoration they do not differ from the ordinary light-slipped vessels.

VESSEL SHAPES

There are bowls, shouldered bowls, ollas, soup-plates, and a few smaller, less standardized pieces.[1]

BOWLS

Although the collection contains only fourteen specimens sufficiently complete for measurement, the abundant sherds provide ample information as to rim profile; and from the larger fragments it is possible not only to calculate diameters with reasonable accuracy, but also to gain a fairly good idea of the general contour of the vessels of which they once formed part (figs. 143, *c*, *d*; 185, *a-f*; 187). The material indicates that the run of the bowls carry still further the tendency toward restriction of the orifice which first manifested itself in Glaze III and which continued through Glaze IV. In Glaze V the point of greatest diameter is well beyond the lip. It is, however, relatively high, the sides running inward and downward toward the bottom in a straighter line and with a correspondingly less fully rounded curve than they do in the earlier types. The result is, of course, that capacity is considerably reduced.

In *size* the bowls vary from 9 to 16¼ inches (fig. 185, *a-f*). There are two between 9 and 10 inches (orifice measurement), three between 10 and 11, two between 11 and 12, three between 12 and 13, one 13¾, one 14½, one 15, one 16¼ (fig. 185, *e*). The average is exactly 12 inches, and measurements taken on a long series of sherds indicate that this approximates the average which actually obtained. Depths run from 3½ inches for a 9-inch specimen to 7¾ for the 16¼-inch bowl. Extremes in *orifice-depth index* are .32 to .49; the average is .405. The larger bowls tend to be deeper in proportion to their width than the smaller ones. The *capacity* of the 9-inch bowl is 2 dry quarts (2.2 litres); the 16¼-inch bowl is too fragmentary to permit determination of its capacity, but it must have held considerably more than the 9½ quarts (10.4 litres) which the 15-inch specimen contains.

The *rim* of the Glaze V bowl is characterized by progressive thickening (fig. 186).[2] The stratigraphic material shows that early pieces such as the one illustrated in figure 186, *a*, do not differ greatly from Glaze IV standards, the exterior being almost straight, the interior gently convex, the angle between rim proper and vessel wall sharply marked. These relatively thin rims were gradually superseded by heavier and heavier ones (*b-f*) with more evenly curving exteriors. Toward the close of the period the rim becomes actually "clubby" (*g-k*), the exterior fully rounded, the inner face strongly convex. The lip is always more or less rounded. The great weight of Glaze V rims gives one the impression that they are much lower than those of Glaze IV. In reality the difference is slight, Glaze IV examples averaging about 1½ inches,

[1] Soup-plates and other unusual forms are described on pp. 263-286.

[2] For notes upon the method of producing the thickening, see p. 385.

Glaze V about 1¼ inches from lip to the point where the thickening ends. The wall of the Glaze V bowl, which like that of all Pecos bowls maintains a practically constant thickness throughout the whole of any given specimen, is lighter than that of any earlier Glaze type. Pieces as thin as $\frac{3}{32}$ of an inch are not unusual, many measure $\frac{1}{8}$ of an inch, the average is about $\frac{5}{32}$, and very few exceed $\frac{3}{16}$ of an inch.

OLLAS

We have relatively full information regarding Glaze V ollas. These vessels tend to break into larger sherds than do the earlier water-jars; and from certain rubbish-filled rooms we recovered sufficient parts of a half-dozen specimens to permit more or less complete reconstruction.

Study of the material indicates that the olla underwent, during the Glaze V period, modifications in shape analogous to those which took place in the bowl.

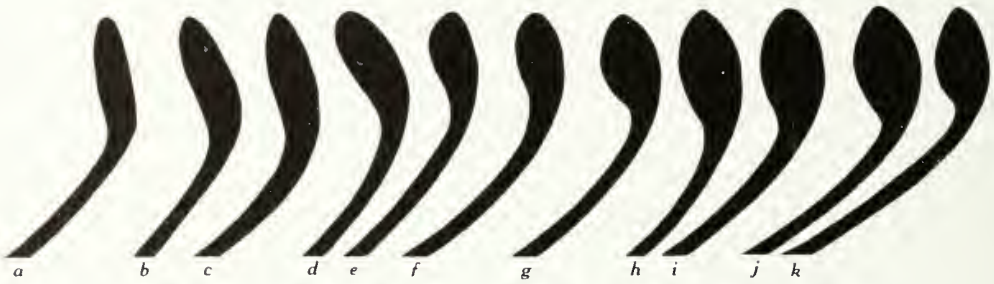


Fig. 186. Glaze V. Bowl rim profiles. The strong thickening is characteristic. Rims *a* and *b* belong to the transition between Glaze IV and Glaze V. (1/2)

Sherds from early deposits are from vessels which in general shape rather closely approximate the Glaze IV form, i.e., they are wide in proportion to their height, there is little break between upper body and neck, the neck slopes gently upward, and there is usually a small recurve at the orifice (figs. 185, *g*; 188, *a-c*). What seems to have been a fairly sudden change, although pieces which might be considered as transitional are not wanting, produces the typical, or middle-period, ollas. Such vessels have very high necks; shoulders which, viewed from the side, are quickly rounding; and straight, unmodified rims with squarish lips (figs. 185, *h*; 188, *d-f*). Data as to the bottom of these ollas are scanty; there are pieces, however, which indicate that the base was rounded, as shown in the restored drawings. There is no evidence that the recurved bottom appeared before very late Glaze V times (see p. 253).

Sizes of Glaze V ollas cannot be reported with accuracy. The most complete of the earlier examples has an orifice 7½ inches in diameter; body diameter, 14½; height, probably 9. One of the ollas of the middle period has 7½-inch orifice; body diameter, 13⅛; probable height, 10½. As to the late olla with recurved rim we can only say that the mouth, measured across the flare, averages between 8 and 9 inches;

Fig. 187. Glaze V. Bowls (Diam. of *d*, 15¾ inches)

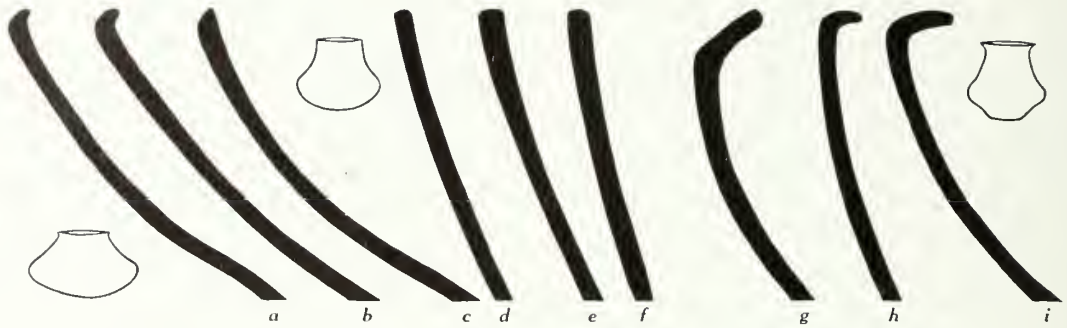


Fig. 188. Glaze V. Olla neck profiles. *a*, *b*, *c:* Early type with gentle slope and slightly outcurved or bevelled (*c*) rim. *d*, *e*, *f:* Middle type, straighter, more nearly vertical; with plain, though sometimes somewhat thickened (*e*) rim. *g*, *h*, *i:* Late type with curving neck; rim strongly recurved. (1/2). The small inset outlines (not to scale) indicate the forms of the vessels; that with outcurved rim is demonstrably correct only as concerns the rim, the body and base are hypothetical.

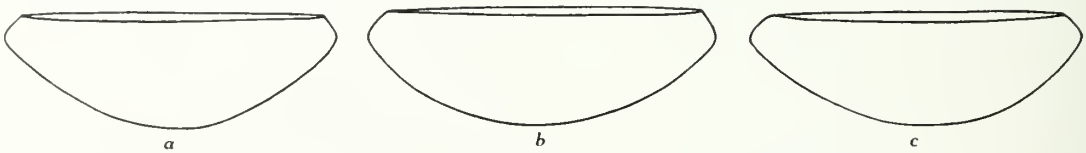


Fig. 189. Glaze V. Shouldered bowls. Note uniformity of shape and close resemblance in outline to the smaller standard bowls (cf. fig. 185, *b*). (1/6)

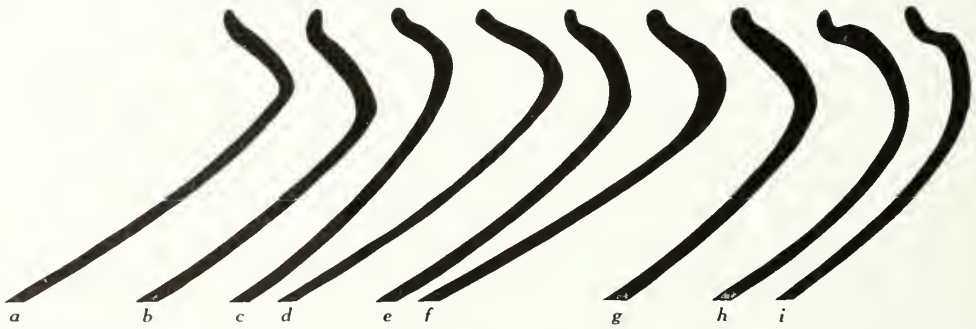


Fig. 190. Glaze V. Profiles of the upper parts of shouldered bowls. The rounded shoulder and more or less recurved rim are characteristic. There should also be noted the convexity of the vessel wall between shoulder and rim; as well as the slight thickening of that region. Specimens with a reverse curve, which produces a gutter-like depression just outside the rim, are frequently seen (*e*, *h*, *i*). (1/2)

the actual orifice, however, is of about the same diameter as that of the earlier types. *Capacities* are not determinable.

SHOULDERED BOWLS

This vessel (figs. 102, *e, f;* 189), which attains its maximum frequency in Glaze V, differs from its Glaze IV prototype in being flatter (about 80% of its height lies below the shoulder, as against 70% in Glaze IV); in having, as a rule, a rounded rather than an angular shoulder (figs. 189, 190; cf. fig. 145); and in being much less variable in shape.

Measurements of five whole specimens and calculations from many large sherds indicate an average orifice diameter of 9½ inches; greatest diameter 10 inches; height, 3⅓ inches. *Orifice-depth index* averages .36; *greatest diameter-depth index*, .33. Capacity is about 2 dry quarts (2.2. litres).

Rims (fig. 190) are much more standardized than those of the Glaze IV shouldered bowls (cf. fig. 146). At the orifice there is almost always a slight turn upward with termination in a rounded lip.[1] Pieces with a noticeable, almost gutter-like, depression just outside the upturned rim are not rare (fig. 190, *h, i*). The vessel wall between the shoulder and the terminal upturn of the rim is gently convex, rather than almost straight, as in Glaze IV; the distance between rim and shoulder is also less (seldom over 1 inch, as against 1¾ inches for Glaze IV). The shoulder, as has been said, is rounded. Another peculiarity of these bowls is the comparatively great weight of the upper wall, which sometimes attains a thickness of ¼ of an inch; while the wall below the shoulder is seldom over 3/16 of an inch thick; some specimens, indeed, have lower walls as light as ⅛ of an inch (fig. 190, *d*).

Shouldered bowl with spout. The single example (102, *h*) is, in every respect save the pitcher-lip spout, a typical Glaze V vessel. The addition of this appurtenance to a shouldered bowl must have been an extremely unusual practice, for not even a fragment of another specimen was recovered. But it is not unique, for a closely similar one was collected by Hewett on the Pajarito Plateau, presumably at Puyé, and therefore probably of Glaze IV period.[2]

GENERAL DECORATIVE FEATURES

Colors. Dark glaze and matte red on light backgrounds. Bowls slipped with red are rare. Upon such pieces the red slip is usually confined to the interior, the decoration being in matte white outlined with glaze, or in glaze alone; their exteriors are light-slipped with red decoration. If the whole bowl is red, the exterior decoration is also white with glaze edgings (fig. 220, *a*), or simply in glaze. Dark shades of red were never, in Glaze V, used upon red slips; this practice was confined to Glaze IV.

Slip extent. *Bowls.* Slip covers the whole interior and the upper part of the exterior; there is usually no slip on the exterior bottom where, the fired paste of

[1] It so happened that the few shouldered bowls found in sufficiently complete condition for the drawing of outlines (fig. 189) and for photographing (fig. 102, *e, f*) did not possess the recurved lip. They are perhaps early specimens.

[2] Hewett, 1908, pl. XV, *g*.

Glaze V being reddish-brown, there is a large round area of that color (fig. 187, side views). The bottom is, in some cases, of so fine and even a color that one suspects the presence of a red wash.

Ollas. Light-colored slip runs from a little below the point of greatest diameter upward to the outer edge of the lip (fig. 208). The lip and the inner part of the neck downward for about 3 inches are slipped red. Red slip also covers at least the upper part of the lower body; there is no evidence that there was an unslipped area at the base, but data as to this part of the Glaze V olla are scanty.

Shouldered bowls. Red slip covers the whole interior and usually the whole exterior below the shoulder; the exterior bottoms of some pieces are not slipped (the bare paste is closely similar in color to the red slip). The upper part of the exterior from the shoulder, or a trifle below its point of greatest diameter, to the edge of the rim is treated with light colored slip as background for decoration. Bowls with a pronounced reverse curve at the exterior base of the upturned rim (see fig. 190, *h*, *i*) often have this little gutter-like area slipped red. A few sherds prove that an occasional specimen was entirely covered with red slip.

ZONES OF DECORATION. *Bowls.* Interior: normally a very narrow zone just below the rim, leaving by far the greater part of the inner surface unornamented; all-over patterns are uncommon. Exterior: repeated free-standing units, or repeated units upon a base-stripe; in either case the design is placed high upon the bowl, beginning at the very lip and seldom extending downward more than 3 inches. There is no decoration upon the interior of the rim or upon the lip.

Ollas (fig. 208). The entire upper body and neck, from below the shoulder to the orifice. The field is divided into two zones; one relatively narrow one about the shoulder, a generally much broader one from the upper edge of the body zone to the lip.

Shouldered bowls (fig. 102, *e*, *f*). A narrow zone from a little below the point of greatest diameter to the base of the upturned rim. Embellishment of the inner side of the rim by groups of ticks is much rarer than in Glaze IV. There is no decoration of the inner surface of the bowl.

BOWL INTERIOR DECORATION

The band, that standby of the Pecos potter from Black-on-white through Glaze III, decreased in importance during Glaze IV, in which period it was sparingly used and also often departed from the rigidly standardized four-panel arrangement of earlier times. From Glaze V bowls the band disappears completely, the interiors of these vessels bearing, in its stead, one of the following three patterns:

Stripe
Pendent birds
All-over

STRIPE

This is interior decoration reduced to ultimate simplicity. Just below the rim a red line with heavy glaze borders encircles the bowl, a third glaze line is set immediately below the lower border; all three are broken by a common exit space (fig. 187,

b). The third line is analogous to the supplementary line seen in certain Glaze IV all-over patterns and is probably derived directly therefrom. A very few sherds show embellishment of the supplementary line by small triangles, dots, or dashes.

The stripe appears upon the interior of every one of our complete Glaze V bowls and upon every one of the several thousand sherds in the collection. In the majority of cases it forms the only decoration; on the remainder added motifs serve to produce the two patterns next to be described.

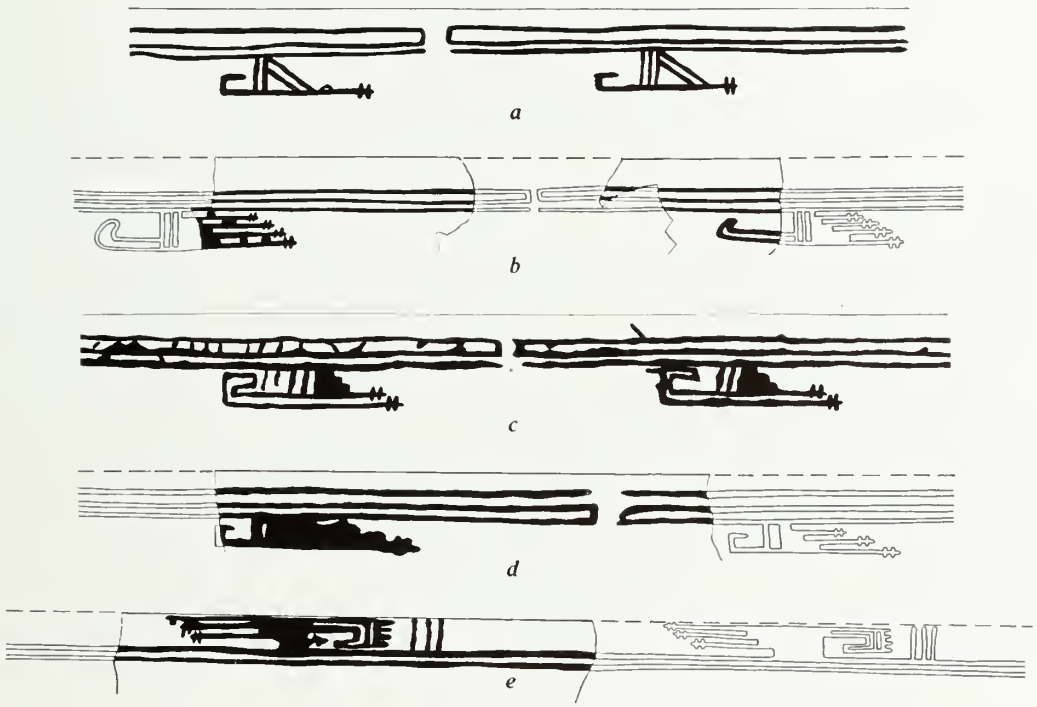


Fig. 191. Glaze V. Pendent birds from bowl interiors. Note absence of red. The pattern at *e* is unusual in that the birds are upon the encircling line; and in that the usual third, or supplementary, line is absent. For exterior decoration of *a* and *c*, see figs. 197, *i*; 193, *c*. (1/8)

PENDENT BIRDS

The inevitable stripe encircles the upper wall of the bowl (fig. 191); but, curiously enough, in the only four examples we recovered, as well as in a closely allied all-over pattern (fig. 192, *f*), its red component is omitted. The two glaze bordering lines occupy their proper positions and close what should be the red area at the exit space; the supplementary line lies below. Why the red, which is seemingly so integral a part of the stripe, should be missing from these few specimens, and from no others is a mystery. The birds, two in number and in each case facing to the left, are much like the Pajaritan birds of Glaze IV, but their tails bear cross marks, which are not

usually seen on Pajaritan birds. Except in figure 191, *d*, they hang from the supplementary line; that member of the stripe, on the vessel in question, lies above the paired lines which, in the conventional stripe, would border the red. The bird at *e* is perched upon, rather than pendent from, encircling lines; this pattern is further aberrant in that there is no supplementary line.

ALL-OVER PATTERNS

We collected nine bowls decorated in this manner (fig. 192). Each of them is encircled by the usual red stripe with glaze borders and supplementary lower line (the supplementary line is omitted in *c;* in *f* there is no red). The figure in the bowl-bottom is in four cases the *capitan* (*d*, *e*, *g*, *h*), in one the jogged cross-bar (*c*); the other four are: a swastika-like pattern of red keys (fig. 187, *d*); a circle with interior arrangement of birdlets on crossed lines (fig. 192, *f*); a semi-lunar figure on a cross-bar (*b*); and four round figures with ticked peripheries and three-line appendages which suggest the projections from the heads of *capitans* (*a*).

The all-over patterns and the pendent birds are obviously derived from Glaze IV prototypes. As a matter of fact, the vessels which bear them are all very early in the Glaze V series. With the exception of the swastika-key specimen (fig. 187, *d*), they might well be classified as transitional. They have relatively thin rims, their exterior patterns (for references to the figures illustrating the exteriors, see caption of fig. 192) have strong Glaze IV affinities, and the glaze lines are far less "runny" than is usual in Glaze V. A check-up of their provenience shows that all of them, save the swastika-key bowl, came from graves. This is a further indication of antiquity, because during the height of the Glaze V period pottery was not used for mortuary offerings. For this reason our knowledge of the type in its fullest development must be derived largely from sherds. Study of this category of material shows that among the three sorts of bowl interior patterns, the stripe is overwhelmingly predominant, and that all-over and pendent bird decorations are almost exclusively confined to the beginning of the period.

BOWL EXTERIOR DECORATION

Although the exteriors of Glaze V bowls exhibit, as compared to Glaze IV, a simplification and reduction in number of devices employed, their embellishment is much more varied than that of the interiors. A classification follows:[1]

Keys
Key-tail figures
Birds
Capitans
Zigzags
Miscellaneous

[1] The number of occurrences is not included in this tabulation because the data are derived from sherds which, because of selective collecting, do not properly represent the relative frequency of the various patterns.

Fig. 192. Glaze V. All-over patterns from bowl interiors. These specimens are from the earlier part of the Glaze V period and might well be considered as transitional between Glaze IV and Glaze V. For exterior decoration of *a*, see fig. 197, *e*; of *b*, fig. 202, *d*; of *c*, fig. 193, *a*; of *d*, fig. 197, *g*; of *e*, fig. 197, *h*; of *f*, fig. 193, *b*. The exteriors of *g* and *h* are not reproduced. For photographs of *b* and *e*, see fig. 143, *c*, *d*. (*Ca.* 1/8)

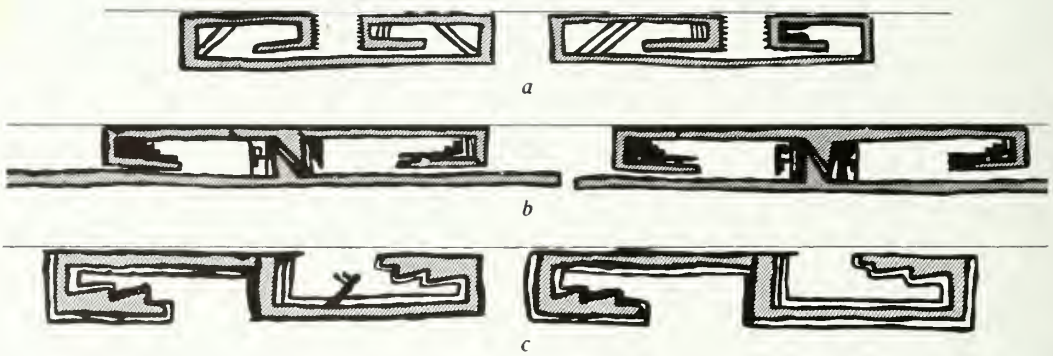


Fig. 193. Glaze V. Glaze-bordered red decorations from bowl exteriors. Double-ended keys. For interior decoration of *a*, see fig. 192, *c;* of *b*, fig. 192, *f;* of *c*, fig. 191, *c*. (1/8)

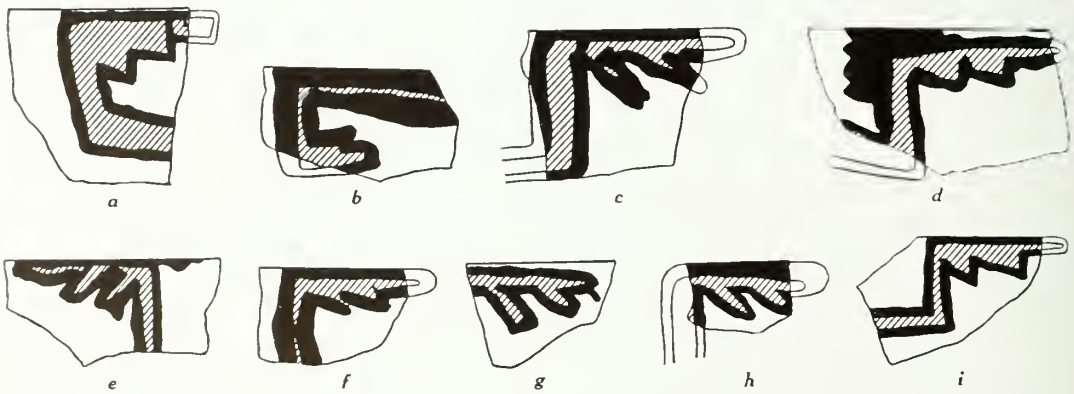


Fig. 194. Glaze V. Keys from bowl exteriors. *a*, *b:* Probably parts of the rare double-ended key-figure. *c*, *d*, *i:* Right-facing keys whose stalks turn to the left; the method of termination of this figure is uncertain. *e:* Left-facing key, an unusual form. *f:* Possibly part of a double-ended figure. *g*, *h:* Fragmentary keys showing the peculiar tooth-like forward facing steps characteristic of late Glaze V. (1/4)

KEYS

Red keys are much in evidence in the exterior decoration of Glaze V bowls; but instead of being independent devices, as they were in Glazes II to IV, they normally appear as parts of the key-tail figures to be described below. We have, indeed, but a single example, from a complete bowl, of the formerly so common double-ended key. It is illustrated in figure 193, *c;* it will be noted that the supplementary glaze line, so dear to the heart of the Glaze V decorator, margins the keys. The sherds exhibit many other keys, but most of these show the attachment, to their vertical backs, of elements which prove them to have been components of key-tail figures. Keys on sherds so broken that their vertical backs are missing might have belonged to double-ended figures, but every such figure has, of course, one right-facing and one left-facing key, so that the sherds should show as many left- as right-facing examples. As a matter of fact, out of thirty fragments with keys whose backs are lacking, only five are lefts. It is therefore probable that most of them come from key-tail figures, whose keys habitually face to the right, and one may conclude that the double-ended key is indeed very rare. I have considered the above small problem at some length

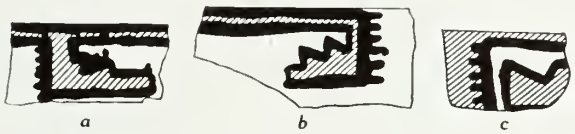


Fig. 195. Glaze V. Unusual keys from bowl exteriors. *a:* Pendent from a stripe. *b:* Part of a double-ended key figure (?). The ticking, common upon the heads of birds, is rarely seen upon keys. *c:* Key in white pigment upon a red background. (1/4)

because the paucity of whole bowls has necessitated close study of the sherds. It also forms a good illustration of the sort of reasoning required when working, as one so often must, with fragmentary material.

Specimens bearing what are probably parts of double-ended keys appear in figure 194, *a, b.* Another sort of key, which is not uncommon, faces to the right, its stalk dropping vertically and then turning to the left (figs. 194, *c, d, i*). We have no specimen to show how this device was completed. If it was double-ended, terminating in a second key turned in the opposite direction, there should be an approximately equal representation of such left-facing keys with stalks bent to the right. As these, however, do not occur at all, one must conclude that the examples we have were single keys mounted at the ends of short segments of a stripe, as are certain birds to be described below (cf. figs. 197, *d, f*). The key pendent from a red stripe (fig. 195, *a*) is not duplicated in the collection; its back is ticked like the heads of many bird figures, as are those of the other two keys (*b, c*) shown in the same figure. Keys are also involved in the devices reproduced in figure 193. That at *b* is obviously allied to a figure seen in Glaze IV (cf. fig. 162, *h, i*). The pairs of accessory birds should be noted; they too are an obvious survival from Glaze IV.

The keys themselves, both in the treatments discussed in the foregoing paragraphs and those used in key-tail figures and *capitans*, are almost always two-stepped although one-stepped (figs. 194, *b*; 195, *a*) and three-stepped (fig. 198, *b*) examples occur. The steps tend to be more saw-toothed than those of Glazes III and IV red keys. Some of them, indeed, actually angle forward (fig. 194, *g*, *h*).

KEY-TAIL FIGURES

With the possible exception of the *capitan*, this is the commonest exterior decoration of Glaze V bowls (figs. 196; 197, *a-c*; 198, *c-k*). Its make-up is simple: a red key rises from a red base-stripe. To the vertical back of the key or, more commonly,

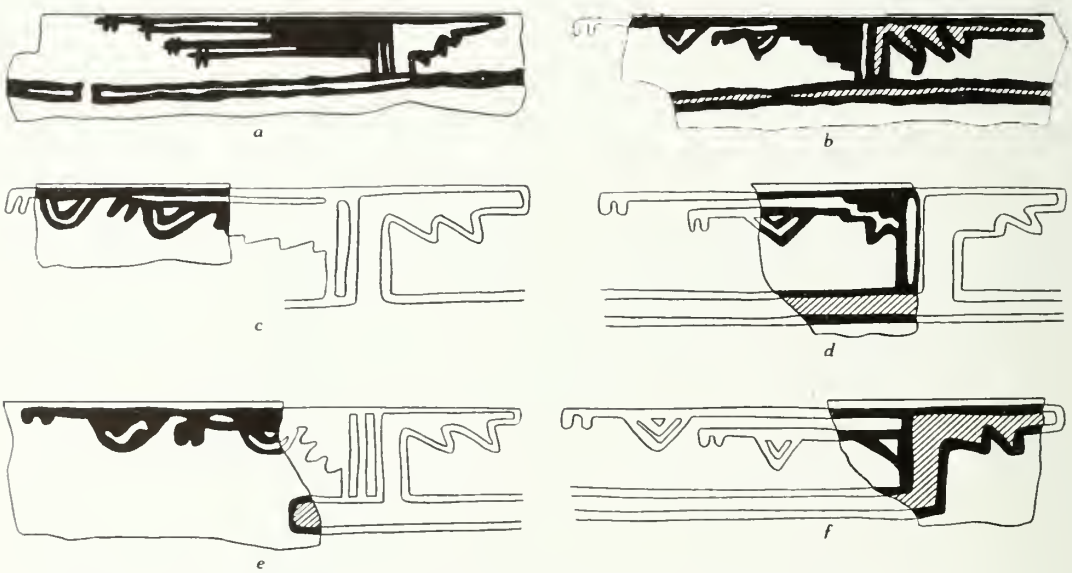


Fig. 196. Glaze V. Key-tail figure from bowl exteriors. The example at *a* is unusual in that the key is not red. Drawn from sherds; see also fig. 197, *a-c*. (1/4)

to a vertical line closely paralleling its back, is attached a device in glaze which, on the analogy of other Glaze IV and V material, is apparently a bird's tail. The figure, indeed, is closely akin to the bird with red forepart (cf. fig. 197, *e*), the key replacing the crooked head of the latter.

From whole bowls we have only the few key-tails reproduced in figure 197, *a-c*. But the sherds provide a great number of more or less incomplete specimens (figs. 196; 198, *c-k*). Study of these shows that the key varies little. It habitually faces to the right (only eighteen out of one hundred and fifty-one face to the left); it is normally two-stepped. Although the tails provide more opportunity for the play of individual fancy, they are also rather rigidly standardized, much more so than the tails of Glaze IV birds with red forepart (cf. figs. 164, 165). The commonest form

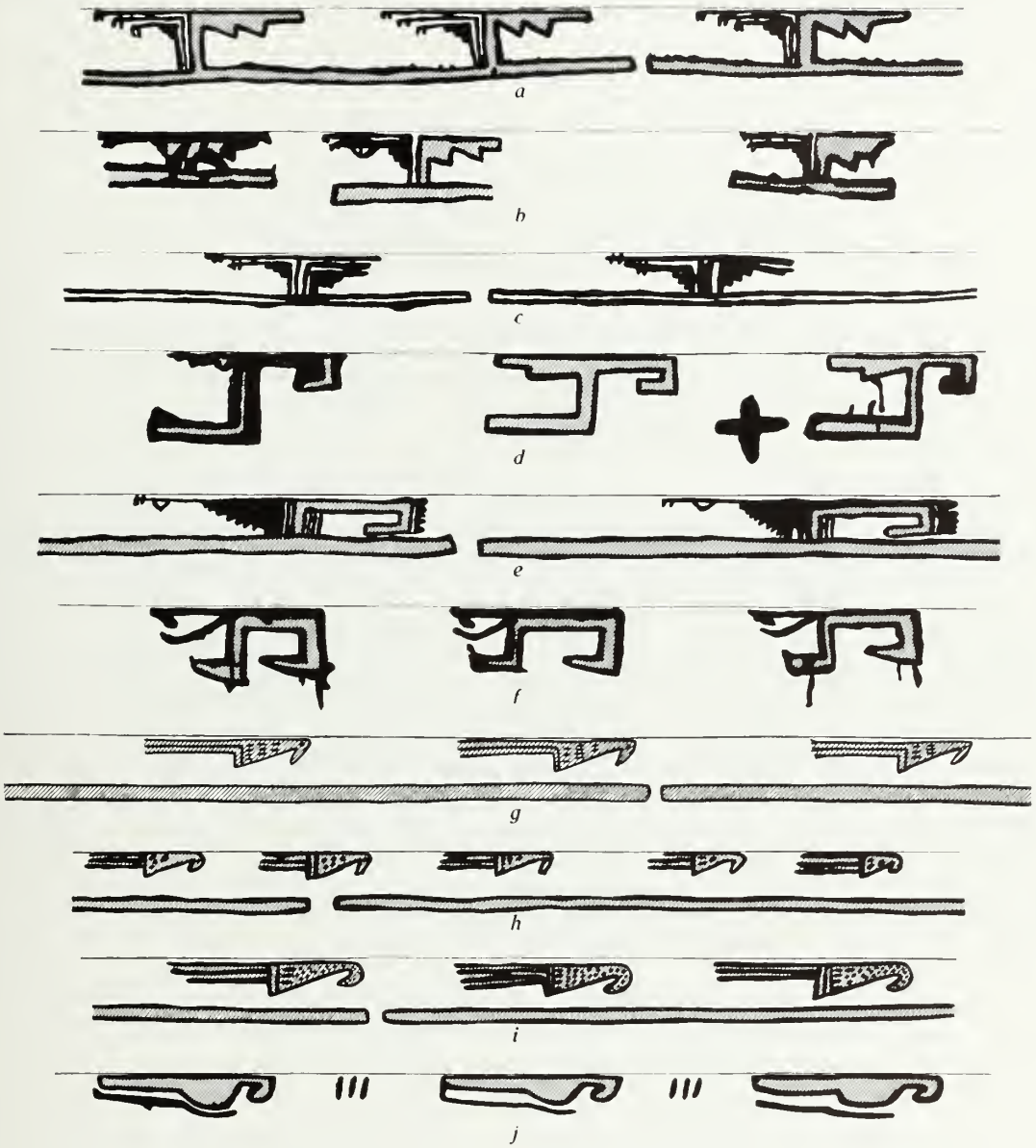


Fig. 197. Glaze V. Glaze-bordered red decorations from bowl exteriors: Key-tail figures and birds. *a-c:* Key-tail figures; *a* illustrates three of four units from a 15-inch bowl. *d:* Bird with terraced, key-like, tail. *e:* Bird with red forepart. *f:* Degenerate form of bird with red forepart. *g-i:* Birds with spotted body. *j:* Bird red throughout, a rare or unique form in Glaze V. The interior decoration of *a-d*, and *f* is a plain stripe (see fig. 187, *b*); for interior of *e*, see fig. 192, *a;* of *g*, fig. 192, *d;* of *h*, fig. 192, *e;* of *i*, fig. 191, *a*. The interior of *j* is not reproduced. (1/8)

Fig. 198. Glaze V. Exteriors of bowl sherds. *a*, *b:* Keys. *c-k:* Key-tail figures. *l-n:* Bird heads. *o*, *p:* Zigzags. *q:* Vertical keys back-to-back. (1/3)

consists of two or three horizontal lines, the upper one the longest, the lower ones progressively shorter. At the end of each line are two short downward dashes, of which the cross-marks of Glaze IV tails are without doubt the prototype (cf. fig. 164). From the lower side of each line there is often, but not invariably, drawn a pendant consisting of two triangles, one within the other, or of two concentric half-circles. The base of the tail is supported, so to speak, by a terraced key-like arrangment (fig. 196, *b*, *d*), rarely by an oblique line (*f*) or by terraced blocking between the lines (*a*).

The number of key-tail figures per bowl is uncertain. On the very large specimen there are four (fig. 197, *a*—because of the pattern's great length only three are shown in the reproduction); two smaller bowls have three (*b*) and two (*c*) respectively. I am inclined to believe, on this evidence and that of the sherds, that the rule

Fig. 199. Glaze V. Birds from bowl exteriors. *a*, *b:* With terraced tail. *c*, *d:* Unusual forms of the bird with red forepart, the tail being greatly reduced (*c*) or lacking (*d*). From sherds. (1/4)

of two, conventional for Glaze IV birds with red forepart (cf. fig. 163) was usually exceeded, three perhaps having been the customary number. As was said above, they are usually set on a red base-stripe; there are, however, many instances in which the stripe is replaced by short segments thereof, each one bearing a key-tail figure (fig. 197, *b*).

BIRDS

Birds appear in four well-defined varieties:

Birds with terraced tail
Birds with red forepart
Birds with spotted body, conventional
Birds with spotted body, naturalistic

Birds with terraced tail. This depiction, which I would have called the key-tail bird had it not been for the danger of confusing it with the figure last described, is rare. We have but one whole bowl which bears such birds (fig. 197, *d*) and twelve sherds (two illustrated in fig. 199, *a*, *b*). The figure seems always to rise from the right-hand end of a short red base, a fragment, so to speak, of a base-stripe. The red of the base rises vertically; at its upper end a right-angled crook-head extends to the right, a key, of the same type as that used in the key-tail figures, runs leftward. The vertical front of the head may be ticked (fig. 199, *a*), but apparently it was more often plain.

Birds with red forepart. Though more common than the foregoing, these are distinctly rarer than key-tail figures. Examples from early Glaze V bowls (see fig. 197, *e*) are closely similar to the same class of Glaze IV birds, i.e., they are placed on a red base-stripe, from which the red forepart rises vertically, bends to the right, and terminates in a right-angled crook-head with ticked front. The tail is in glaze alone and, as nearly as can be determined from our fragmentary material, it does not differ from the same part of the key-tail figure (cf. fig. 196). In later Glaze V times these birds, as is indicated by a number of sherds, became much simplified and the base-stripe was segmented to form short individual supports (fig. 197, *f*).

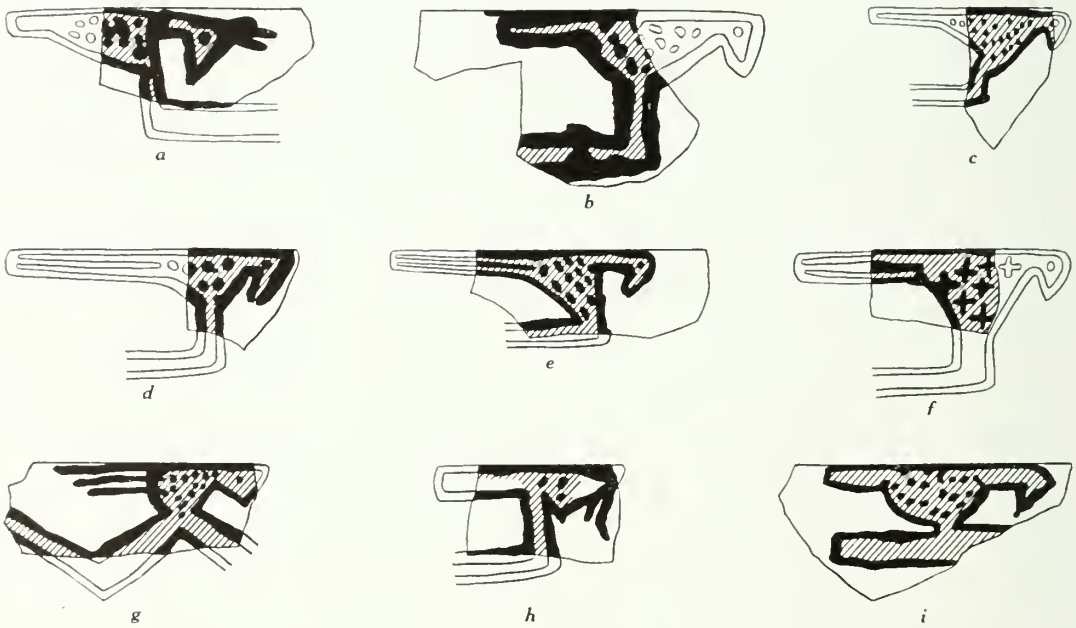


Fig. 200. Glaze V. Birds with spotted body, conventional type. These are late examples; for a perhaps earlier form see fig. 197, *g-i*. From exteriors of bowl sherds. (1/4)

Birds with spotted body, conventional type. I suspect that these birds were relatively rare, particularly during the later part of the Glaze V period. We have the three whole bowls whose exterior decorations are illustrated in figure 197, *g-i;* there are also some fifty sherds which bear parts of such birds. The relative abundance, however, of the fragmentary material is probably due to selective collecting. The figures, usually three in number, are set close below the rims and above, but seldom touching, a red base-stripe. They are without doubt directly derived from the Glaze IV birds with spotted body, having the same vaguely triangular, spotted bodies, peculiarly shaped heads, and long tails composed of

plain horizontal lines. The greatest difference lies in the omission of the chevron-like arrangement which, in Glaze IV, separates the body from the tail (cf. fig. 168). Figures perhaps allied to this occur on apparently late bowls (fig. 200).

Birds with spotted body, naturalistic type. Upon sherds of what appear, from rim form and quality of glaze, to be late bowls are birds of a more variable nature; a group of them is illustrated in figure 201. They develop naturalistic features, such as rounded bodies and even wings and legs.

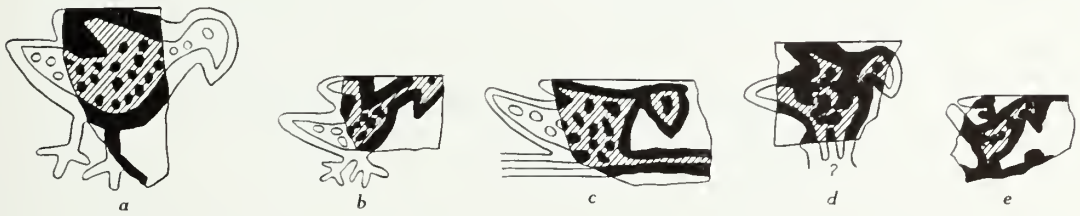


Fig. 201. Glaze V. Birds with spotted body, naturalistic type. From exteriors of bowl sherds. (1/4)

CAPITANS

Capitans (figs. 202-204) constitute one of the commonest forms of decoration upon the exteriors of Glaze V bowls. How closely they approach the key-tail figure in frequency cannot certainly be determined from the material in hand, for all sherds bearing parts of the *capitan*, an interesting depiction and one easily recognized even when fragmentary, were naturally saved, whereas many pieces ornamented with the key-tail were discarded. This of course gives the former an unduly high representation among the selected sherds. A check of the unselected lots, although such sherds are mostly too small to insure certain identification of designs, indicates, however, that the *capitan* is firmly intrenched in second place.

The figure much resembles its Glaze IV prototype. Two *capitans*, as before, comprise the decoration of the bowl's exterior; there is the same long rectangular body, short neck, and triangular head with three appendages (fig. 202). The appendages, however, are shorter and are more often pointed than blunt-ended. The apex of the triangular head always points toward the body, never outward, as it often does in Glaze IV. Human features: (dots or dashes for eyes and mouth) invariably appear (figs. 202; 203; 204, *c*, *d*, *f*, *g*); the nose is not represented save in one evidently early example (fig. 202, *d*). The neck is frequently undecorated; but in most cases it is crossed by a pair of lines, normally plain, rarely dotted. The red outline of the body encloses an elongated rectangular space, which is cut by vertical lines (pairs or threes) into two or three panels (fig. 202, *a*, *b*). The panels normally contain oblique arrangements, which almost always take the form of two small, one-step keys on long stalks (figs. 204, *k-m;* 205, *a*, *b*). The stalks may (fig. 205, *b*) or may not (*a*) be

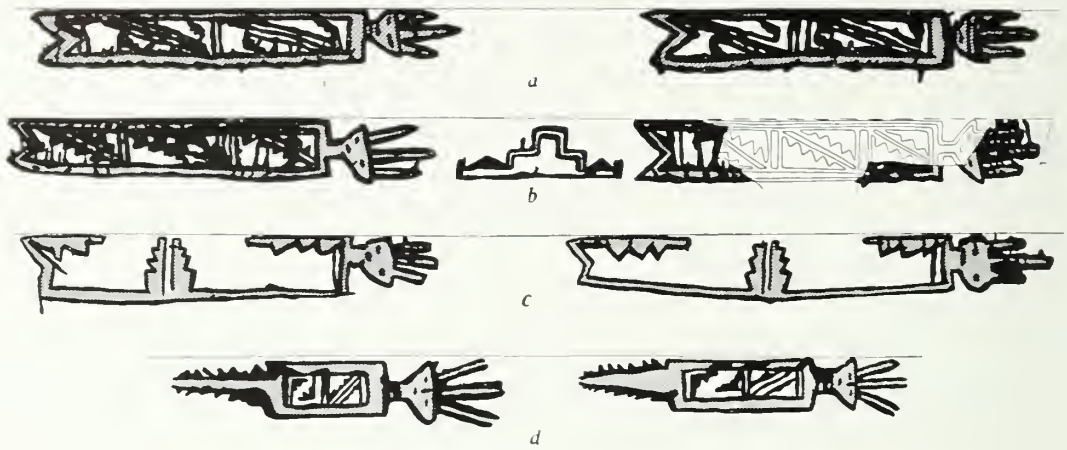


Fig. 202. Glaze V. *Capitans* from bowl exteriors. From *b* there has been omitted a second terraced figure, of which, on the original specimen, traces may be seen between the head of the right-hand figure and the tail of the left. The bowl from which *d* is reproduced is early (see photograph, fig. 143, *c*). (*Ca.* 1/7)

Fig. 203. *Capitan* heads from bowl exteriors; showing the remarkably uniform rendition of this figure. The example at *a* is one of the few *capitans* with double-key body (cf. fig. 202, *c*); that at *f* is unusual in that it faces to the left. (1/4)

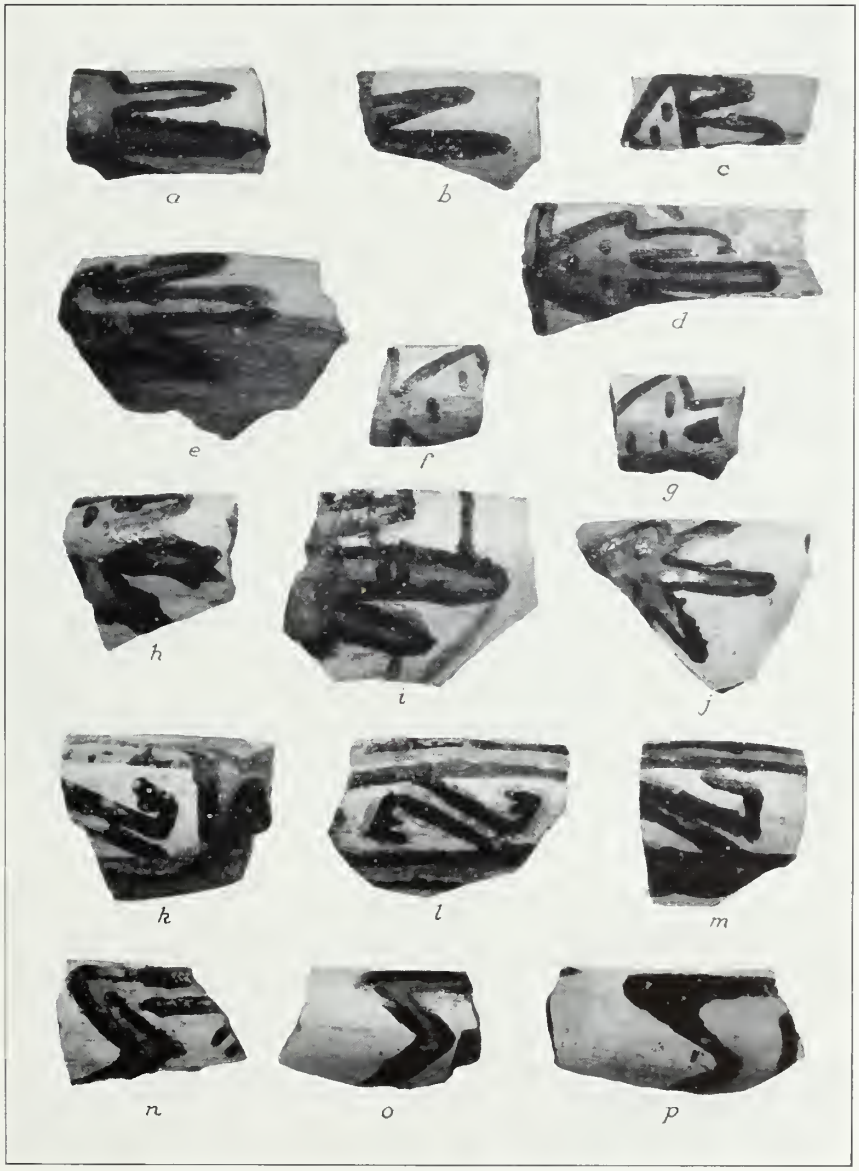


Fig. 204. Glaze V. Exteriors of bowl sherds bearing parts of *capitan* figures. *a-j:* Heads. *h-m:* Body decorations. *n-p:* Body terminations. (1/3)

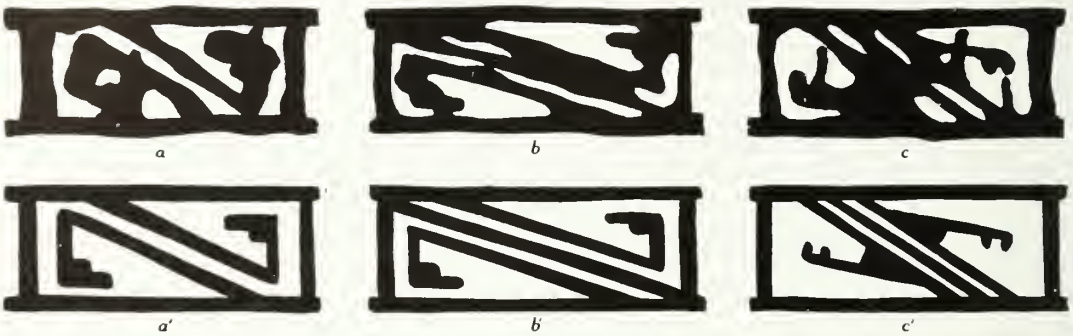


Fig. 205. Glaze V. Panels from *capitan* figures: exact copies above; renderings of intended designs below. From sherds. (*Ca.* 1/3)

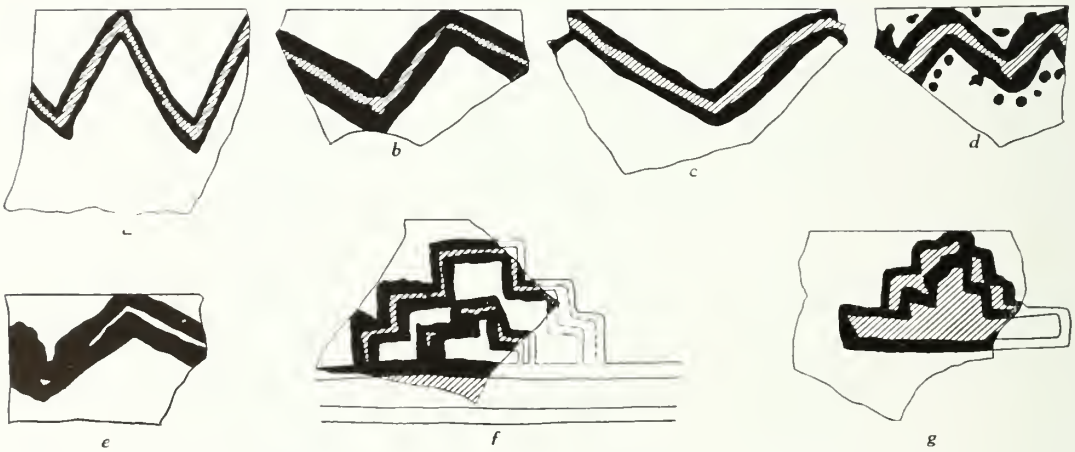


Fig. 206. Glaze V. Exteriors of bowl sherds. *a-e:* Zigzags. *f, g:* Terraced figures. (1/4)

Fig. 207. Glaze V. Unusual decorations from bowl exteriors; those at *a, b* suggest the sunburst device of Glaze III (cf. fig. 131); those at *c, d* are obviously derived from Glaze IV prototypes (cf. fig. 157, *i-l* and *m-t*). (1/4)

separated by a line connecting diagonally opposite corners of the panel; in either case they run parallel to each other and are bent in such a way as to bring the keys into indirect opposition (i.e., the two stalks, or the stalks and the central diagonal, lie between the keys). Other sorts of body decoration are rare: oblique birdlets (fig. 205, *c*), oblique lines with dots or small triangles (fig. 202, *b*—best seen in restored portion). One or two sherds seem to show a survival of the Glaze IV unpaneled field with zigzag (fig. 169, *a*, *d*). The body terminates, in almost every case, in an angular notch (figs. 202, *a*, *b;* 204, *n-p*); there is one instance of a tail-like protuberance (fig. 202, *d;* the bowl bearing these *capitans* is a very early one); a single sherd exhibits what appears to be a typical bird tail.

There remains to be described a variant of the *capitan* which is found on one of the complete bowls. The sherds prove that, although uncommon, it is not unique. As may be seen in the drawing (fig. 202, *c*) the body is a long, double-ended key figure, the two keys facing each other. The typical *capitan* head emanates from the back of the right-hand key, the equally typical notched termination is formed by a bend in the rising stalk of the left-hand key; from the horizontal stripe which connects the keys there arise two other keys, set back-to-back. A sherd from a similar *capitan* is illustrated in figure 203, *a*.

Among the approximately two hundred sherds bearing recognizable parts of *capitans*, only four have the heads pointing to the left (one shown in fig. 203, *f*).

ZIGZAGS

Zigzags (figs. 198, *o*, *p;* 206, *a-e*) are relatively rare (seventeen sherds). All are of oblique type. A red, glaze-bordered stripe forms the zigzag; its upper points reach the edge of the rim. There is no evidence as to whether or not it has an exit space. In two cases red is omitted, the zigzag consisting of two parallel glaze lines (fig. 206, *e*). In five cases glaze dots are set along the bordering lines (fig. 206, *d*).

MISCELLANEOUS EXTERIOR DECORATIONS

The extraordinary standardization of Glaze V design is illustrated by the fact that among the thousands of sherds examined in the field only twenty or thirty were found to bear decorations that failed to fall into one or another of the few categories described above. The majority of such pieces are too small, too battered, or too confused by running of the glaze to permit identification of the figures which they bore. Upon some of them, however, are legible devices: terraces (fig. 206, *f*, *g*); half-circles or circles with ticked edges (fig. 207, *a*, *b*) which seem to be survivals of the sunburst of Glaze III and IV (cf. figs. 131; 174, *d*, *e*); and rectangular or triangular protuberances from a red base-stripe that carry accessory birds (fig. 207, *c*, *d*—these are surely hold-overs from the Glaze IV decorative system—cf. fig. 157, *i-t*).

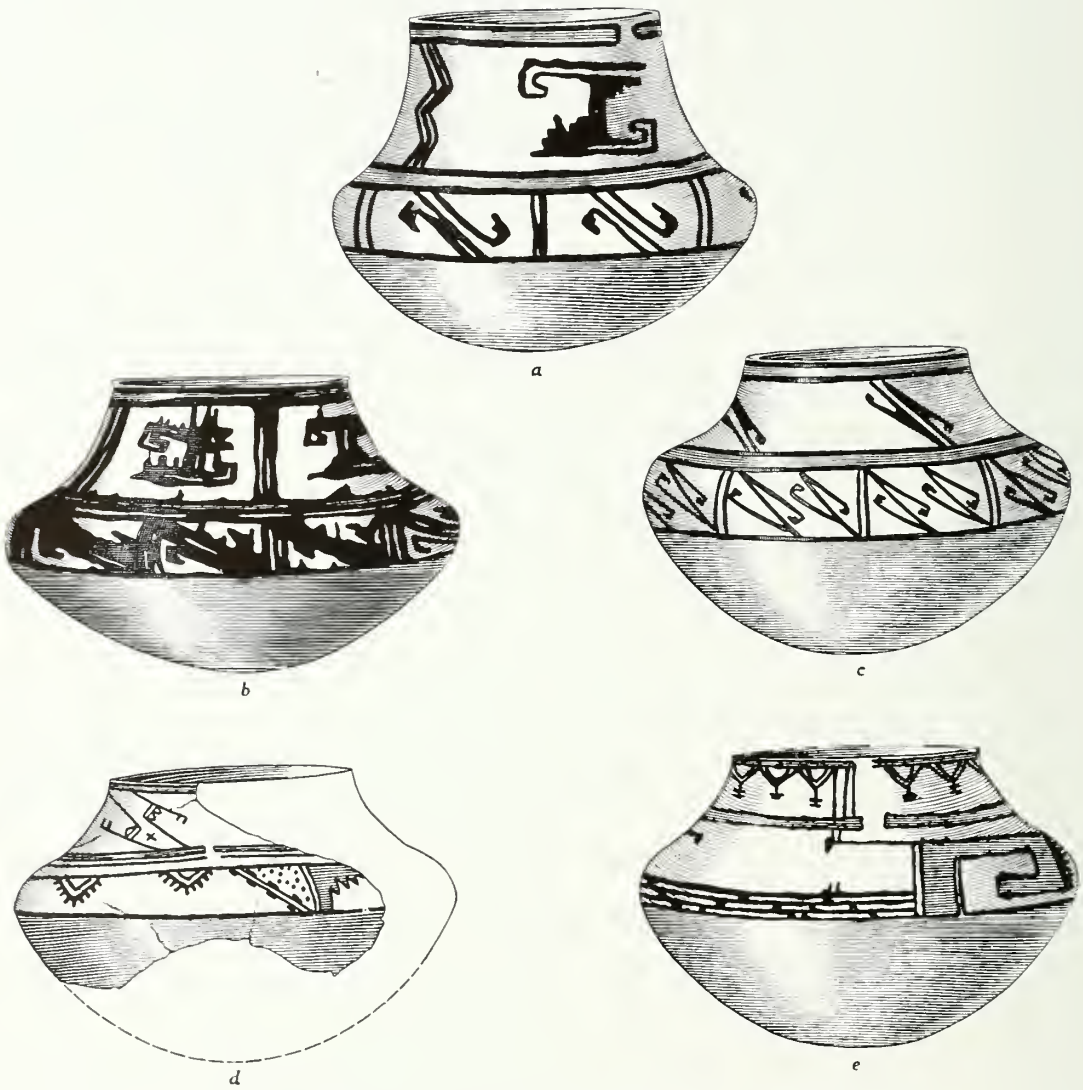


Fig. 208. Glaze V. Ollas. *a-c:* Typical specimens of the middle period. *d, e:* Early Glaze V, transitional from Glaze IV; note that neck decoration is relatively narrow and that body decoration of *d* ends at point of greatest diameter. (1/6)

OLLA DECORATION

One might justifiably consider that the typical Glaze V olla of the middle period (fig. 185, *h*) has no neck whatever; one could hold, on the other hand, that above the rounded shoulder the whole vessel is neck. This is merely a matter of terminology. The Glaze V decorator, however, obviously considered that a distinction should be made, for following traditional practice she divided her field into two zones, one about the shoulder and one covering the upper part of the olla (fig. 208, *a-c*). These are here called the body and neck zones.

BODY

This zone encircles the rounded shoulder from well below the point of greatest diameter to an approximately equal, or slightly greater, distance above that point. It is thus a relatively narrow field which is almost always treated as a paneled band. There are no framing lines, the band terminating below in a single banding line, its upper banding line being the lower glaze border of the red stripe which divides the

Fig. 209. Glaze V. Unusual decorations from olla bodies. *a:* Key-tail figure. *b:* Key. *c:* Cross. *d:* Sunburst. Drawn from sherds. (1/6)

field of the body from that of the neck. Sets of two or three vertical lines cut the band into six to eight panels. There is extraordinary uniformity in the decoration of the panels. They are repetitive, rather than alternating (A,A,A, etc. instead of A,B,A,B, as in the older Glazes). Each one (figs. 205, *b'*; 208, *a*, *b*) is crossed obliquely by a line connecting diagonally opposite corners and separating two key figures whose stalks emanate from the upper and lower banding lines close to the same corners which are joined by the central dividing line. The stalks are bent once, thus bringing the small one- or two-stepped keys into indirect opposition (fig. 205, *b'*). The pattern is not found in bowl interiors, but it occurs commonly in the bodies of *capitans* from the exteriors of bowls (see p. 223); and it is often seen upon shouldered bowls (fig. 215, *w-z*). On olla bodies it occurs again and again with no variation save that produced by poor drawing or by greater or less running of the glaze. Upon one olla each panel contains two sets of lines and keys (fig. 208, *c*).

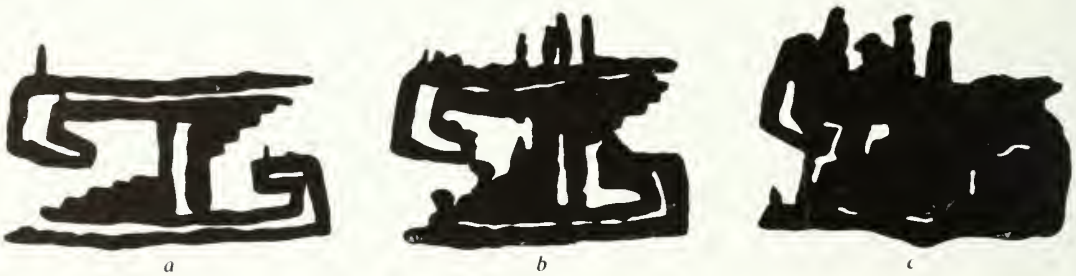
While perhaps 90% of all Glaze V olla bodies bore the above decoration, there are sherds which prove that a few other devices were employed. Among these are three with parts of what seem surely to have been key-tail figures (fig. 209, *a*), one with a large red key (*b*), one with a red cross (*c*), and one with "sunbursts" (*d*). All the elements just listed are characteristic, it should be noted, of bowl exteriors; they

thus violate the earlier Glaze canon of decorative correspondence between bowl interior and olla body, and between bowl exterior and olla neck.

NECK DECORATION

The zone of the neck, as has been said, is relatively broad (fig. 208, *a*, *b*). It is bounded above by a red stripe set just below the edge of the rim, below by a second stripe. The lower one apparently always, the upper at least sometimes, contained an exit space. Although the neck is less monotonously treated than the body, there is a great preponderance of the figure about to be described.

DOUBLE-BIRD. The illustrations (figs. 208, *a*, *b*; 210; 212, *b*, *c*, *d*, *g*) make clear the nature of this very uniform ornament which, like the oblique line-and-key body pattern, varies only in detail and through the effects of running glaze. Two birds,



a *b* *c*

Fig. 210. Glaze V. Three double-bird figures from the neck of a fragmentary olla. These drawings are exact copies, made to show the effect upon design of the running of the glaze. The side of the vessel bearing the figure at *a* was evidently subjected to relatively light firing, the heat becoming progressively more intense, and producing correspondingly greater fluidity of the glaze, on the parts upon which *b* and *c* had been painted. (7/16)

one upright, the other inverted, and facing in opposite directions, are joined by a vertical central element. The birds have rectangular crook heads and terraced tails. They are in glaze alone, no red appearing in any of the many examples in the sherd collection. The double-bird is not found on bowls, nor have I seen a prototype, so far as the paired depiction goes, in any earlier Glaze. It possesses some similarities to figures on bowl interiors (cf. fig. 197, particularly those shown at *c*) duality of presentation and lack of red being common characteristics; but the double-birds lack the cross-marks on the tail. If the two forms are indeed allied, it is possible that the width of the space to be filled on an olla neck led to the placing of the figures in juxtaposition, an arrangement obviously unsuitable for a narrow band.

There seem to have been either two or four double-birds to each olla. They are commonly separated from each other by a vertical two- or three-line zigzag (fig. 208, *a*), less often they occupy true panels (*b*).

DOUBLE-TAIL (figs. 211; 213, *m*). Symbolic simplification may perhaps be suspected in the case of this ornament, which is merely the double-bird with the

heads omitted. It is used in twos or fours on olla necks in the same way as is the double-bird. The figure might be considered the result of careless painting were it not for the fact that we have three examples from different pots, and for the further fact that the longer member of the tail is in two cases crossed by short lines, which are not seen on the tails of any double-bird in the collection.

Birds. Small birds, obviously derived from the accessory birds of Glaze IV, perch in pairs upon zigzags (fig. 213, *g*, *h*), upon oblique lines (*b*), and upon vertical lines (*d*). There is evidence of a survival of the Pajaritan bird upon the necks of early Glaze V ollas. The fragments, however, bear too little of the figures to warrant reproduction. Two sherds exhibit bird tails with cross lines; these might be from birds with red forepart (cf. fig. 197, *e*), from key-tail figures (cf. fig. 197, *a*), or possibly from double-tail figures (cf. fig. 211, *a*). But large birds of the older types are very rare, the birds red throughout so often seen on olla necks of Glaze III and

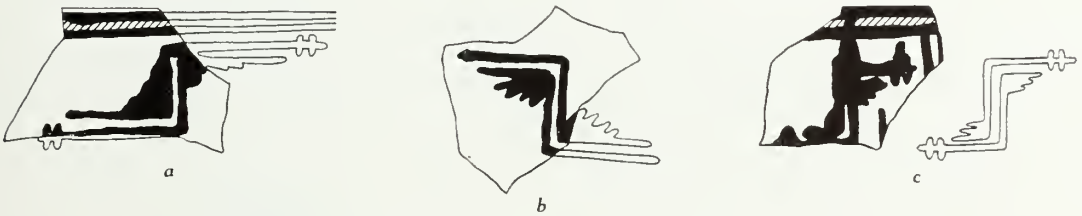


Fig. 211. Glaze V. The double-tail figure, an olla neck decoration. At *c* a restoration indicates the probable original shape of an example badly defaced by the running of the glaze. (1/4)

sometimes on those of Glaze IV are lacking; and birds with spotted body, such as appear on the exteriors of Glaze V bowls, are represented by but two illustrable specimens (figs. 213, *k*; 226) and a part of a head.

Key figures. Uncommon. Both double-ended (fig. 213, *e*) and single (*f*) examples appear. They are found, almost exclusively, on the necks of the earlier Glaze V ollas. On the taller, later ollas the key figure is extremely rare. Figure 213, *j* illustrates one of the very few specimens in the collection.

Zigzags set vertically are much used (fig. 212, *f*, *h*), generally alternating, as nearly as can be ascertained from the fragmentary material, with the double-bird, when they serve to produce panel-like spaces (fig. 208, *a*). Mounted on the angles of some of the zigzags are pairs of accessory birds (fig. 213, *g*, *h*). Horizontal zigzags occasionally run between vertical zigzags (*l*), or join sets of paneling lines (*i*).

Oblique line decorations are confined, apparently, to the early Glaze V olla with low neck. Except for crudeness of execution, which no doubt is partly due to lack of control over the glaze, they are much like the oblique line ornaments of Glaze IV: edged with triangles (fig. 213, *a*) or with accessory birds (*b*). In some cases the multiple lines are replaced by a glaze bordered red stripe, which runs obliquely between the upper and lower neck stripes (*b*).

Fig. 212. Glaze V. Olla neck sherds. (Width of *b* at rim, 3¾ inches)

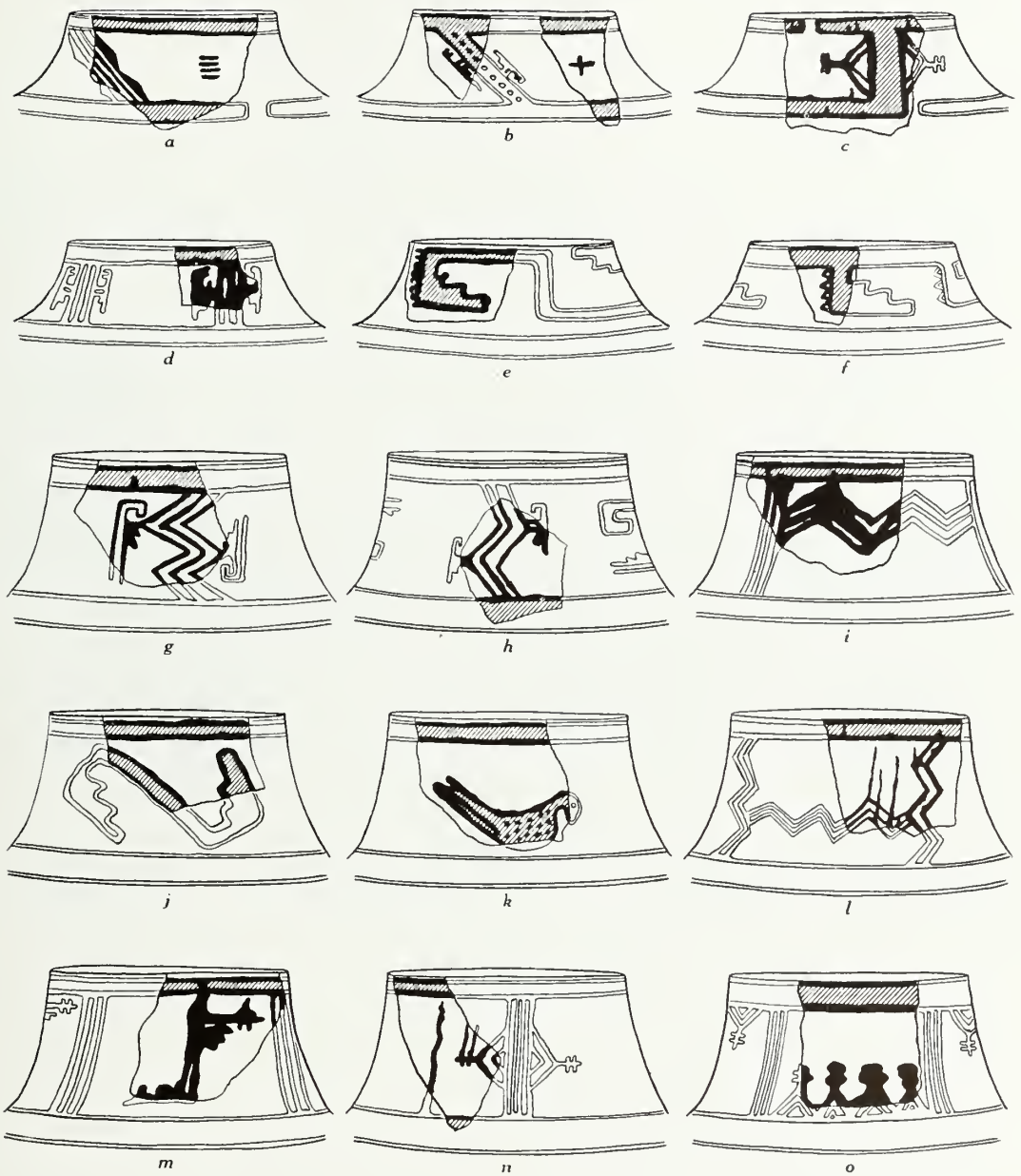


Fig. 213. Glaze V. Olla necks drawn from sherds. The parts of figures restored in outline ignore the running of the glaze; they thus represent these figures as probably conceived by the potter. *a-f:* Ollas of the early type with relatively low necks. *g-o:* High necked ollas of the middle period. (*Ca.* 1/6)

Cross-apex triangles. The base of each one of these little figures is composed of two concentric triangles (fig. 213, *n*). From the apex of the outer triangle there projects a short line at or near the end of which are two short cross-lines suggesting the terminal markings of bird tails (cf. fig. 191). The figures usually appear in pairs, one on either side of a vertical red bar (fig. 213, *c*) or a set of vertical lines (*n*), an arrangement much like that of the Glaze III and IV swallowtail (cf. figs. 136, *i*; 178, *h*). Sets of four cross-ended triangles are also placed on horizontal lines (fig. 213, *o*).

SHOULDERED BOWL DECORATION

The decoration of the shouldered bowl is confined to the very narrow zone between the point of greatest diameter and the base of the usually slightly recurved rim, which, being seldom much over 1 inch in width, is naturally treated as a band (fig. 102, *e*, *f*). The patterns are in glaze on light colored slip. Red extremely seldom appears as part of the design, but in the specimens with a gutter-like depression just outside the rim (fig. 190, *h*, *i*), that area is often treated with red slip, thus producing a polychrome effect. There is no interior decoration; ticking of the inner surfaces of the rim is unusual.

Framing lines, sometimes found on Glaze IV shouldered bowls, are absent. The banding lines, apparently seldom broken, lie respectively at or a little below the widest part of the shoulder; and at the base of the recurved rim (directly at the lip, if there is little of no recurve). Paneling is habitual, but not invariable; two, less often three, heavy vertical lines produce the subdivisions.

Zigzags	24
Triangles with produced sides	4
Triangles with apex marks	3
Cross-apex triangles	10
Oblique lines	7
Oblique lines with birdlets	26
Birdlets back-to-back	126
Birdlets single series	23
Pajaritan birds	10
Small semi-naturalistic birds	10
Indirectly opposed oblique keys	18
Keys on vertical stalks	32
	293[1]

Zigzags (fig. 214, *a*, *b*, *c*) are relatively less common than in Glaze IV (cf. tabulation, p. 211). They are coarsely drawn, usually double, lines which were evidently used (see *a*, *c*) to fill panels. Other decorations involving angular lines are shown at *d* and *e*; these are unique.

[1] The frequency counts are taken from the general digging sherds which bear legible designs.

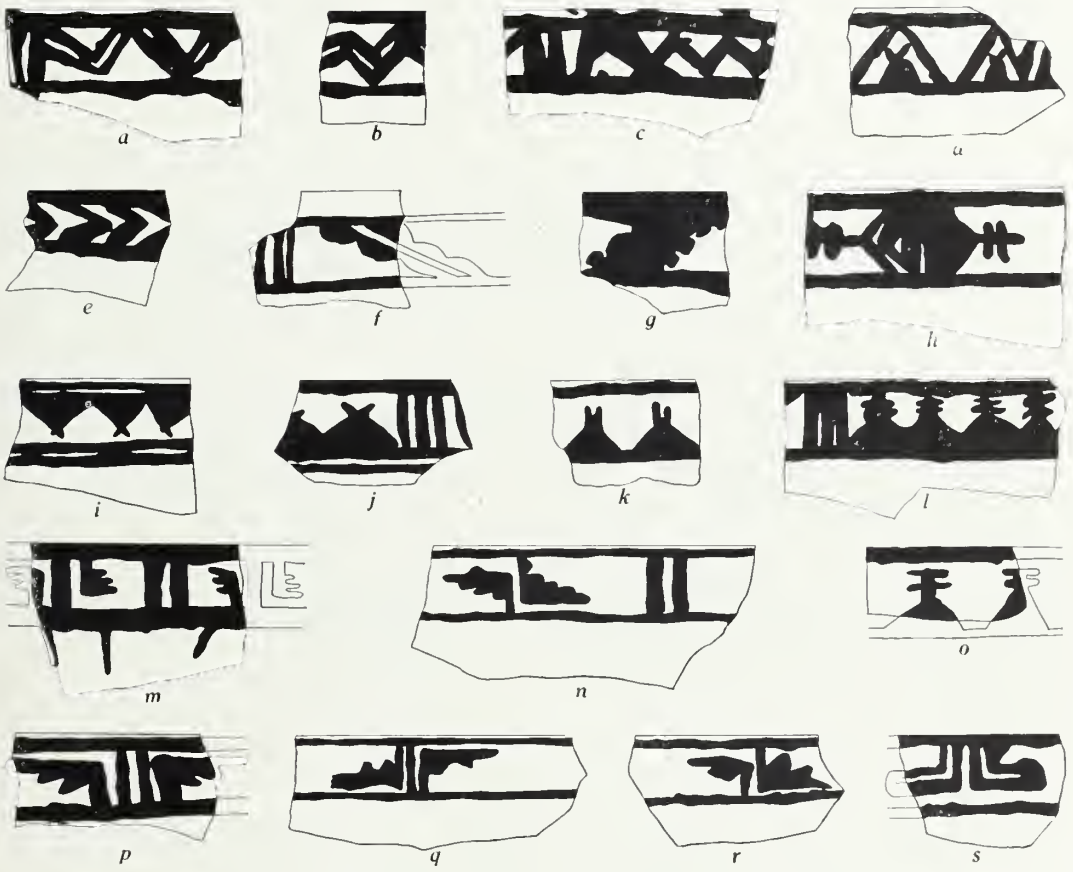


Fig. 214. Glaze V. Shouldered bowl sherds. *a-c:* Zigzags. *d:* Triangles. *e:* Chevrons. *f*, *g:* Oblique lines (*g* was doubtless drawn as three parallel lines, the two outer ones edged with dots, an excellent example of the result of running glaze). *h*, *l*, *o:* Cross-apex triangles. *i*, *j:* Triangles with produced sides. *k:* Triangle with apex marks. *m*, *n*, *p-s:* Key figures. (1/3)

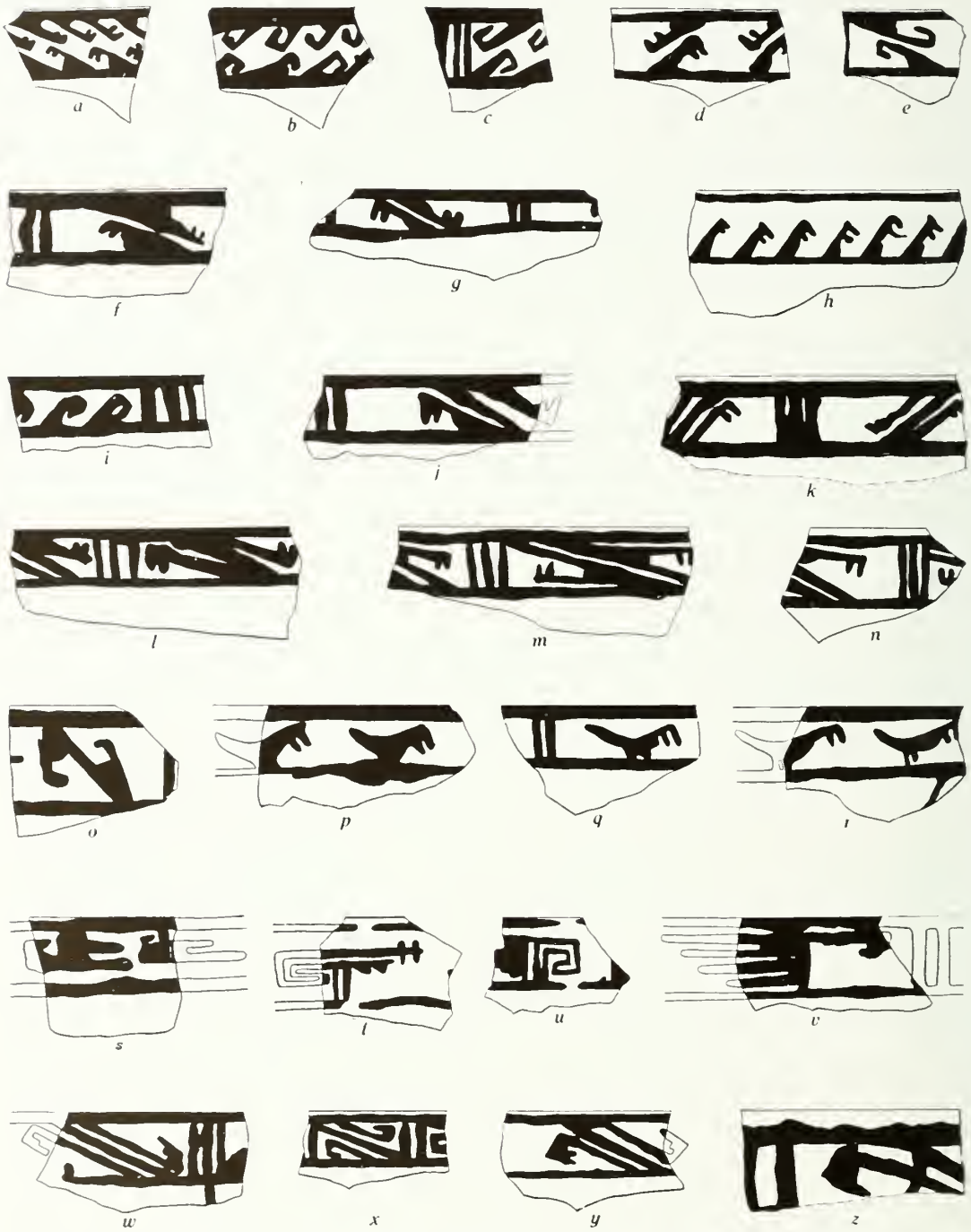


Fig. 215. Glaze V. Shouldered bowl sherds. *a-g:* Birdlets back-to-back. *h, i:* Birdlets in single series. *j-l:* Birdlets separated by oblique line. *m-o:* Birdlets upon oblique line. *p-r:* Small semi-naturalistic birds. *s-v:* Pajaritan birds. *w-z:* Indirectly opposed keys. (1/3)

Triangles with produced sides (fig. 214, *i*, *j*) and Triangles with apex marks (*k*) are, save for cruder execution and running of the glaze, not distinguishable from the same elements of Glaze IV decoration (cf. figs. 183, *h*, *i*; 217, *g*).

Cross-apex triangles (figs. 214, *h*, *l*, *o*; 217, *l*). This peculiar figure, which has been described above (p. 244), occurs sparingly upon shouldered bowls. It appears, as in olla neck decoration, on paneling lines (fig. 214, *h*) and in series upon the banding line (*l*, *o*).

Oblique lines (fig. 214, *f*, *g*) are uncommon. Dotting of the outer lines is the commonest method of embellishment, but such refinements are usually rendered ineffective by the spreading of the glaze.

Oblique lines with birdlets (fig. 215, *j-o*). This figure has two variants. The commoner (*j-l*) consists of an oblique line and two birdlets, facing away from each other, one heading upward, one down. The birdlets (which have double-dash heads) are attached to the banding lines and are very similar to birdlets back-to-back, the only difference being their separation by the oblique line (cf. *j* and *g*). The structural analogy of this arrangement to the indirectly opposed keys (*w-z*) should be noted. In the second variant (*m*, *n*) there are two oblique lines upon each of which is an inward-facing birdlet with double-dash head. Apparently both the above forms are always used singly in panels; they thus differ from the majority of birdlets back-to-back, next to be considered, which are often employed in multiple series to fill a panel (fig. 216, *c*, *f*) or even to constitute the whole pattern of an unpaneled band (*d*, *e*).

Birdlets back-to-back (figs. 215, *a-g*; 216, *c-f*; 217, *q*, *t*, *u*) are by far the commonest decoration of Glaze V shouldered bowls; appearing on almost half of all sherds examined. They differ very little, save in poorer execution, from Glaze IV examples (cf. fig. 183, *f*, *g*, *j-o*); their heads, however, are more regularly of the two-dash variety than in the earlier type. The arrangement, as was said above, is in panels, or in unbroken series encircling the vessel.

Birdlets, single series (figs. 215, *h*, *i*; 216, *b*; 217, *v*) are used in panels (fig. 215, *i*) and in what would appear to be unbroken repetition (*h*).

Pajaritan birds (fig. 215, *s-v*) are uncommon. They are used, presumably always in panels, for the decoration of the wider bands. The normal attributes of the Pajaritan bird (rectangular crook head, vertical members, line tail) all seem to be present, but the material is very fragmentary. It should be noted, however, that the head of one figure (*u*) is in the manner of the bird with red forepart (cf. fig. 197, *e*); while the bird at figure 215, *t* strongly suggests the double-bird of olla necks (cf. fig. 210).

Small semi-naturalistic birds (fig. 215, *p-r*) are of about the same frequency as Pajaritan birds. They are quaint little creatures with double-dash heads, cocked-up tails and, as a rule, two legs. They would appear to be a realization of the birdlet; or, less probably, an attempt to imitate, without use of red and on much reduced scale, the realistic red birds with spotted bodies (cf. fig. 201).

Indirectly opposed oblique keys (fig. 215, *w-z*). This is the arrangement so regularly employed for the decoration of olla bodies (fig. 208, *a*), and also as a filler for the elongated field of the *capitan* (fig. 205). It is normally set in the middle of a

panel. Apparently, as on ollas and in *capitans*, it repeats instead of alternating with another figure.

KEYS ON VERTICAL STALKS (figs. 214, *m*, *n*, *p-s*; 216, *a*, *b*) are, after birdlets back-to-back, the most abundant shouldered bowl decoration. They are typical of Glaze V, appearing very seldom in Glaze IV. Two small keys with two or three usually angular steps emanate from the top and bottom framing lines respectively. They are set either directly back-to-back (fig. 214, *n*, *r*) or are separated by a vertical line (*m*, *q*). In either case they occupy the middle of a panel. Variants appear at *p* and *s*.

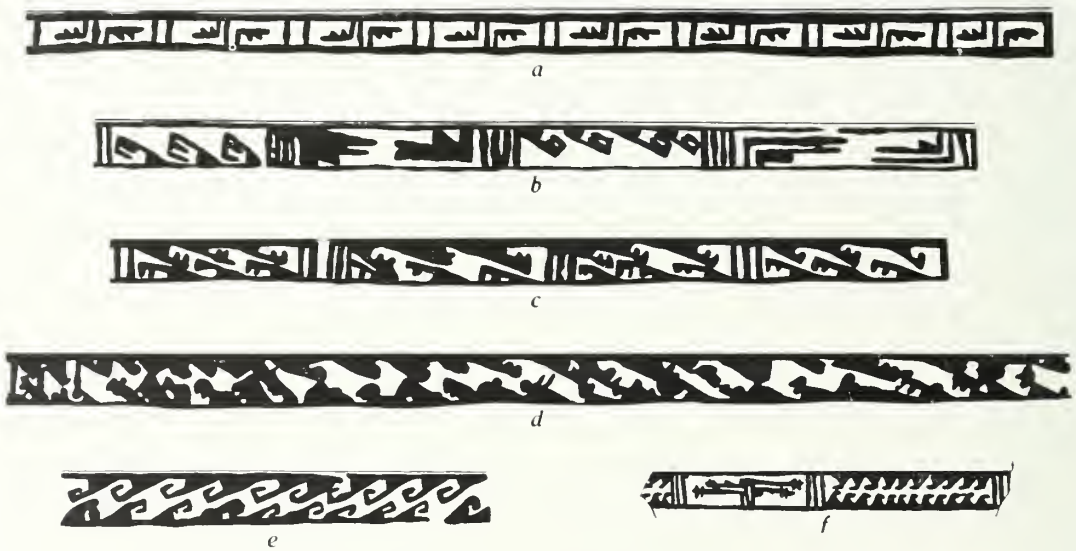


Fig. 216. Glaze V. Bands from shouldered bowls. Although paneling is the rule, some bands of back-to-back birdlets are unpaneled (*d*, *e*). The drawing at *e* represents about one-third of the pattern encircling a bowl; that at *f* is from a sherd of doubtful period—it should possibly have been classified as Glaze IV. (1/6)

Fig. 217. Glaze III, IV, V. Sherds from shouldered bowls. *a-c:* Glaze III. *d-k:* Glaze IV. *l-v:* Glaze V. (1/3)

LATE GLAZE V

There is a small group of specimens obviously allied to Glaze V, but differing from the latter in several important particulars, which deserves separate, even if brief, description: first, because to have included it with standard Glaze V would have created a false impression of variability in that actually very uniform type; second, because the specimens in question will come in for consideration in discussing the relationship of Glaze V to Glaze VI. It need only be stated, at this point, that both stratigraphic and typological evidence strongly indicate that this pottery was made at the very close of the Glaze V period; and that it may or may not have been transitional (in the genetic sense) between Glaze V and Glaze VI.

GENERAL CHARACTERISTICS[1]

The material can best be described as run-down or degenerate Glaze V. The clear, yellowish slips of the time of that type's preponderance are replaced by dull, pallid, dirty-white coatings, so thin that swab-marks are to be seen on almost every piece, the dark paste often being streakily exposed. The finish, however, is not bad nor does the glaze suffer from lack of luster. It has run, however, even more freely than that of Glaze V, so much so, indeed, that although the designs are simple, they are often entirely ruined. Red elements persist.

VESSEL SHAPES

Bowls, shouldered bowls, and ollas occur. Soup-plates doubtless were made, but I am unable to distinguish them from standard Glaze V specimens.

BOWLS

The *rim* stands practically vertically (figs. 218, 219, *a-f*), rather than curving inward as in earlier Glaze V (cf. fig. 186). The point of greatest diameter is therefore usually at the orifice. The base is flattish (fig. 218, *a*, *b*) or actually flat (*c*, *d*). *Measurements* of our one whole example (figs. 218, *d*; 220, *c*) are: diameter, 12½ inches; height, 6 inches. *Orifice-depth index* .48; *capacity* 7 dry quarts (7.7 litres). The bowls restored from sherds show great variation in *orifice-depth index:* figure 218, *c*, .37; *a*, .32; *b*, .28. This last is the shallowest bowl ever found at Pecos; it seems, however, to represent a form not unusual during this period, as there are several fragments of similar pieces. The *rims* (fig. 219) of the Late Glaze V bowls mark a return toward the canons of Glaze IV (cf. fig. 141); i.e., they are more nearly vertical and very much thinner than in true Glaze V (cf. fig. 186). As a rule the exterior surface of the rim is straight or very faintly convex, though a slight recurve appears in the sherd illustrated in figure 219, *f;* and a stronger concavity in *g*. Such specimens

[1] Late Glaze V appears to be indistinguishable technologically from standard Glaze V.

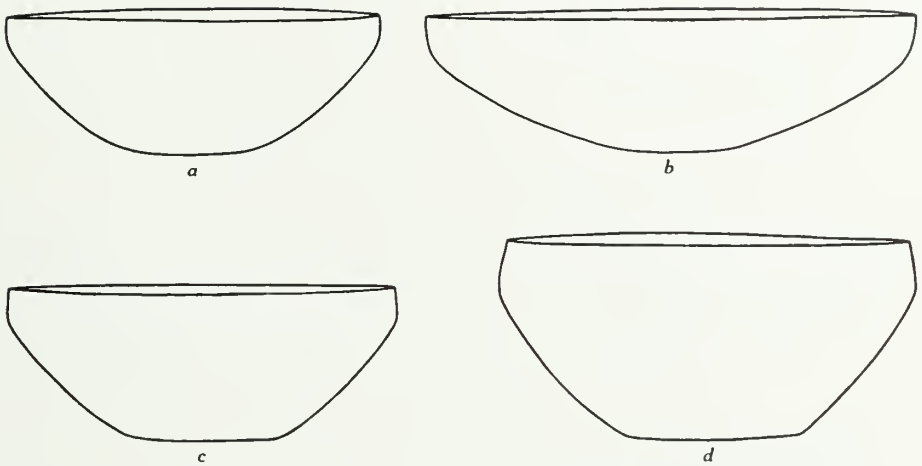


Fig. 218. Late Glaze V. Bowl shapes. (1/6)

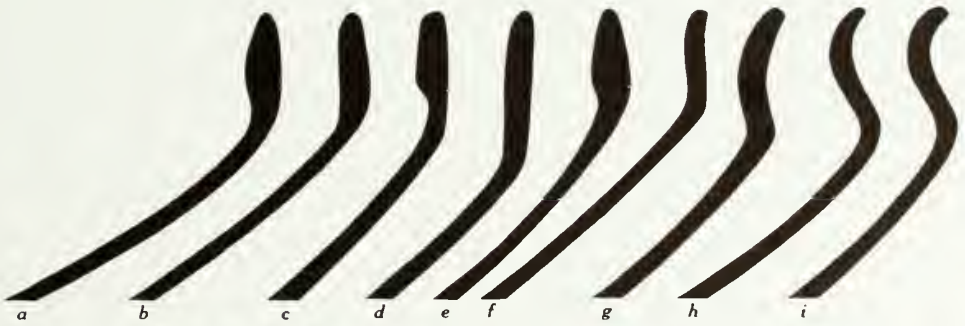


Fig. 219. Late Glaze V. *a-e:* Profiles of normal bowl rims. *f, g:* Rims with recurve. *h, i:* Rims of shouldered bowls. (1/2)

Fig. 220. Glaze III, V, VI. Glaze III (*b*) and V (*a*) bowls with red slip and white glaze-bordered decoration. *c:* Late Glaze V. *d:* Glaze VI. (Diam. of *c*, 12¾ inches)

might be considered transitional to Glaze VI (cf. fig. 223), but they are extremely rare.

SHOULDERED BOWLS

We have only a dozen or so sherds referable to this form (fig. 219, *h*, *i*). The shoulder, it will be noted, is lower than in Glaze V and the rim curls strongly outward.

OLLAS

Again, there are only sherds; and these are not sufficiently large to permit more confident restoration of the vessels from which they emanate than the miniature drawing in figure 188. But the typical form appears to have been not unlike that of

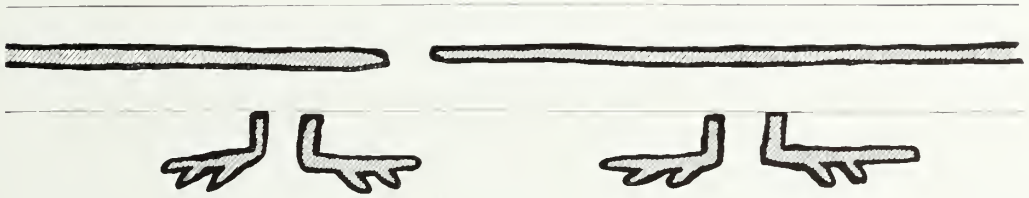


Fig. 221. Late Glaze V. Above: Interior decoration of bowl shown in fig. 220, *c*. Below: Exterior decoration of same. (1/8)

the Plain Black olla, i.e., to have had a high, gently curving neck, protuberant shoulder and recurved bottom (cf. fig. 250). At the *rim* there is a strong outward flare (fig. 188, *g-i*), which serves further to ally these ollas with Plain Black and clearly to differentiate them from standard Glaze V.

DECORATION

Extent of slip and zones of decoration are the same as in Glaze V. The decorations themselves are greatly simplified (fig. 220, *c*, *c'*). The bowl interior bears, as in Glaze V, a glaze bordered red stripe, which may or may not be paralleled below by a supplementary glaze line. On one sherd the stripe is replaced by a glaze-bordered red zigzag. No interior has birds or other figures, nor do birds, key-tails, or *capitans*, all so abundant in Glaze V, appear on the exterior. The usual device seems to have been a glaze-bordered red zigzag or a very degenerate form of the key placed in pairs just below the rim (fig. 221). Shouldered bowls have no interior decoration; on the outside, between shoulder and lip, is a single-line glaze zigzag (fig. 102, *g*). The olla has a glaze-bordered red stripe at the top of the neck immediately below the flare at the orifice. The neck itself seems to have been unembellished. There was presumably a second stripe at the shoulder, but as to this part of the vessel we have no reliable data.

GLAZE VI[1]

One can perhaps best characterize this type by stating that before it achieved the dignity of a number in the chronological series it was called "Degenerate Glaze." It is just that. Its status at Pecos will be discussed later. Here we need only remark that it is the last and worst of the Glazes and that it is very sparingly represented in the collection.

GENERAL CHARACTERISTICS[2]

Glaze VI is two-color pottery. Polychrome effects, it is true, were sometimes produced by the use of both red and white slips on the same vessel, but the decoration proper is in glaze alone, there being none of the glaze bordered red embellishments so typical of Pecos pottery from Glaze II to Glaze V inclusive. It is impossible to characterize Glaze VI by surface color, for there is no standard. Two sorts of slip appear; light, and what, for want of a better term, may be called red. The light slips are muddy yellowish-whites and dirty creams; the reds are dull rusty browns, fawns, dark reds. So wretched are many of the slips that one is often in doubt as to whether a light or a red cast was intended. Most slips are uneven, "washy," applications. Crackling does not seem to occur, but the coating, perhaps because of its thinness and failure to cover minute irregularities in the underlying surface, leaves numberless tiny exposures of the paste, which are to blame for the dull, lustreless appearance of so many of the light-slipped pieces. The red slips, being somewhat heavier, are more successful. Firing seems to have controlled very poorly, for there is considerable range of shade upon almost every large sherd. Surface finish leaves much to be desired. A few red specimens are reasonably smooth; some are actually polished. The lighter ones, however, offer little evidence of care in working the slip over after application; some of the visible tool-marks have evidently been produced upon the underlying paste.

The glaze accords perfectly with the other deplorable qualities of this pottery in being mostly untaken, particularly on red vessels. It ran badly, but without developing the beautiful glossiness of Glaze V.

VESSEL SHAPES

Bowls and ollas are the only forms represented in the Pecos collection. We recovered no examples of the "platters of various odd outlines, cups or mugs with loop-handles, melon-shaped vessels, rectangular vessels, etc." noted by Nelson at the Tano ruins.[3]

[1] Comparable material constitutes Mera's Group F, the type ware of which is "Kotyiti Glaze-polychrome or Glaze-on-red." Mera's subtype "Cicuye Glaze-polychrome or Glaze-on-red" is a minor variant, at Pecos, of Glaze VI (Mera, 1933, pp. 7, 8).

[2] For Miss Shepard's technological description, see pp. 514-516. [3] 1916, p. 175.

BOWLS

Although we have only one complete specimen (figs. 220, *d*; 222, *b*), several sherds are large enough to permit accurate restoration (fig. 222, *a*, *c-e*). The bottoms of these bowls tend toward flatness; some (*d*) have a small base which is truly flat. The sides rise in a gentle convex curve to the base of the very broad rim, which is sometimes vertical (*c*), more rarely slanted a little inward (*b*), most commonly somewhat flaring (*a*, *d*, *e*). The point of greatest diameter is normally at the orifice; only in the few cases in which the rim cants inward from the vertical is the bowl wider below (*b*).

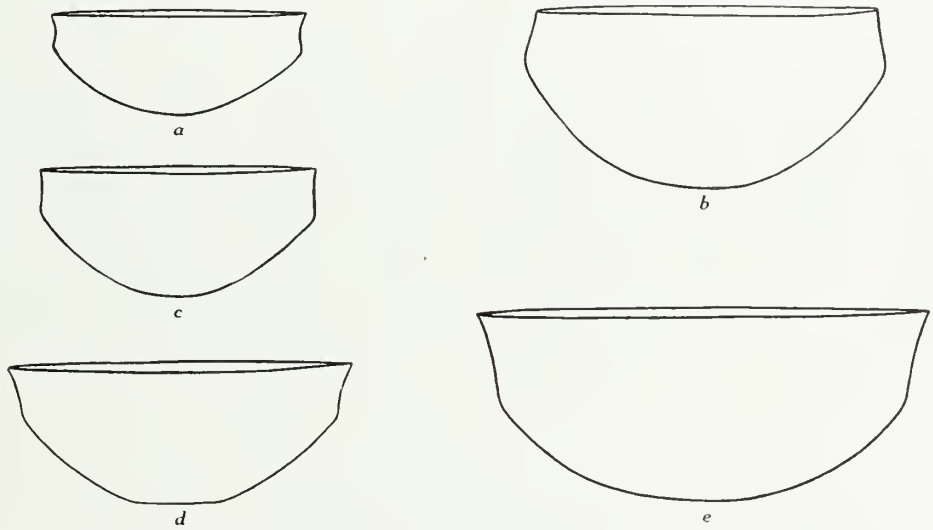


Fig. 222. Glaze VI. Bowl shapes. These outlines, except *b*, which is a whole bowl (see fig. 220, *d*) are drawn from large sherds. They are correct for the upper parts of each specimen; the bottom of *d* is also correct; those of *a*, *c*, *e* are restorations. (1/6)

Measurements of the one whole piece (figs. 220, *d*; 222, *b*) are: diameter at orifice, 11 inches; height, 5½ inches. There are sherds of bowls of from 8 to 14, or perhaps even 15 inches, in diameter; the gradation between these two extremes is complete, i.e., there are apparently no definite size groups. *Orifice-depth index* of the whole bowl is .50; the sherds give probable indices varying from .36 to .47. *Capacity* of the whole bowl, 7 dry quarts (7.7 litres). *Thickness* of vessel walls is normally about ¼ of an inch.

Rims show a very abrupt change from the canons of Glaze V. Instead of being low, strongly thickened and tending to incline inward (cf. fig. 186), the Glaze VI rims (fig. 223) are high, very little thickened, and are either vertical or incline outward. A gentle outward recurve is almost always present. In height the specimens

vary from 1½ to nearly 3 inches, the largest bowls having the highest rims. The whole rim may be very slightly thickened (fig. 223, *a*, *d*), or the extra weight may lie toward the middle (*g*), or at the lip (*f*); definitely thickened rims, such as *k*, are not common.[1] The lip is generally round, occasionally flattish (*f*, *i*).

OLLAS

Extremely few Glaze VI olla sherds were found and those that came to light are all too small to supply valid data as to shape. Study of the fragments indicates, however, that the vessel was not unlike the Plain Black olla (cf. figs. 250, 252), with small, probably recurved, base; protruding, rounded shoulder; and high neck with sharply flaring rim (cf. fig. 188, *g-i*).

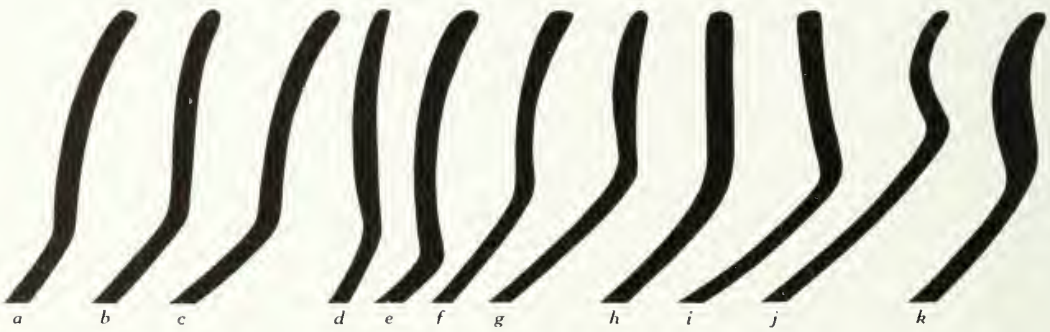


Fig. 223. Glaze VI. Bowl rim profiles. The relatively great height, little or no thickening and gentle reverse curves are characteristic. Most rims cant outward from the vertical; specimens canting inward (*i*) are unusual. (1/2)

GENERAL DECORATIVE FEATURES

Colors. Dark glaze on light-colored or red backgrounds; no red appears in the designs.

Slip extent. *Bowls.* There seems to be no rule. The following arrangements have been noted: red within and without; light within and over whole exterior except the bottom; red outside, light within; light without, red within; light within and to the base of the rim on exterior, whole lower exterior red.

Ollas. The data are very meagre. I have identified no red Glaze VI ollas. Light-colored specimens seem to have been slipped from just within the flaring rim to well below the shoulder, the exterior base being unslipped.

Zones of decoration. *Bowls.* The interior of many pieces was left without decoration. Where interior embellishment occurs it lies below the rim, although

[1] Mera's "Cicuye Glaze-polychrome or Glaze-on-red" type (Mera, 1933, p. 8).

"runs" of glaze often invade the rim. Exterior decoration is confined to the rim. *Ollas:* Apparently the whole upper body, from below the shoulder to the base of the orifice flare.

PATTERNS

To dignify the crude daubs, which in Glaze VI pass for ornament, perhaps unduly stretches the above term. The standard device is a roughly drawn zigzag,

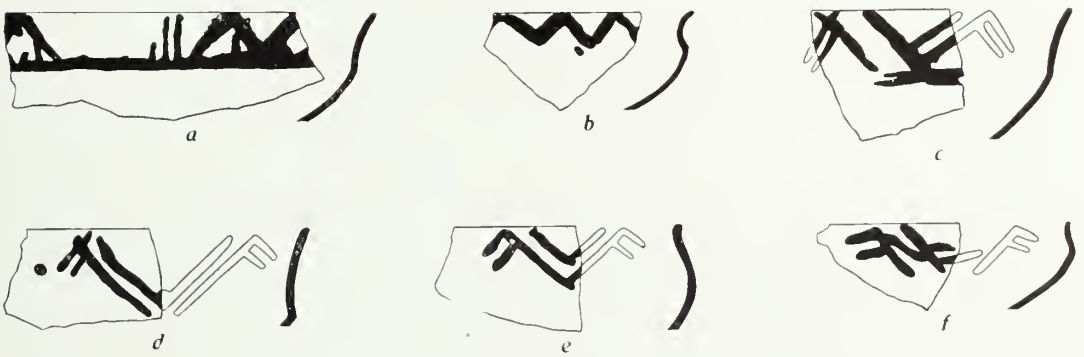


Fig. 224. Glaze VI. Exterior decoration of bowl rims. The profiles show the great variation in rim form. (1/5)

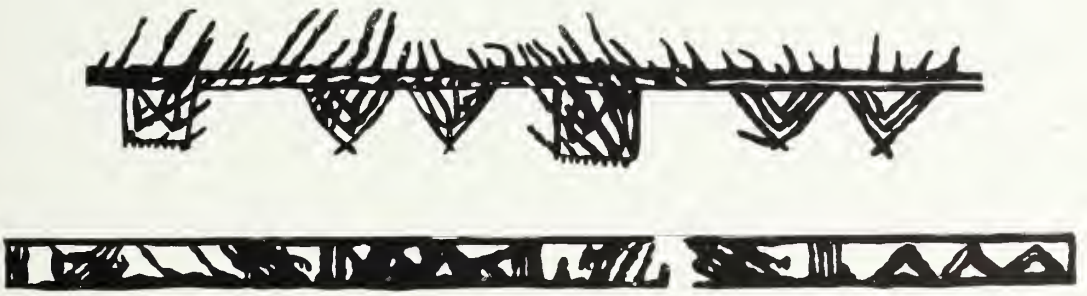


Fig. 225. Glaze VI. Decoration of the bowl shown in fig. 220, *d*. Above: Interior. Below: Exterior. (1/6)

its lines so wide that they might well have been applied with the finger (fig. 224, *a*, *b*). Zigzags, or parts thereof, appear again and again, particularly on the exterior of the bowl rim. What seem to have been intended for triangles, or perhaps semicircles, are also common (fig. 225, upper). Occasionally a more ambitious design was attempted, such as the panelled band on the exterior of our one whole bowl (fig. 225, lower). This has birdlets on oblique lines, alternating with sets of triangles. But such

figures were invariably ruined by the running of the glaze, so badly, in fact, that it is usually next to impossible even to guess at what was intended. The only unit decoration which can be made out is illustrated in figure 224, *c-f*. In this we presumably see the ultimate degeneration of the bird. As far as I know, there is no local prototype of the figure. It occurs on the exterior of several bowl sherds.

SUMMARY OF THE GLAZE TYPES

There have now been passed in review the six sequent types into which, for convenience of description, we have divided the Glaze pottery found at Pecos. The making of this ware was, it must be remembered, never a static art. Change was constantly going on. And although in the preceding pages it has been stressed that the types merged almost imperceptibly into each other, and although certain stylistic trends have been pointed out, it seems desirable, for the clearer depiction of Pecos glaze-painting as a living cultural process, to present a very brief running account of its career.

I at one time considered including in this volume item-by-item studies of the development of the Glazes, in which, for example, the form of the bowl rim would be followed through its various changes; and, in decoration, methods of framing and subdivision of bands, the metamorphoses of design elements, etc. would be traced from beginning to end. All this material, however, is contained in the descriptive sections, whence it can be extracted without undue difficulty. The data concerning the Glaze types have, indeed, been arranged in the same order in each section to facilitate comparison and to permit any single aspect of shape or decorative style to be examined, so to speak, serially. But the principal reason for omitting detailed recapitulation is that to be of maximum value it should be cross-referenced to concurrent developments elsewhere in the Rio Grande. And this, for lack of information as to sites other than Pecos, cannot as yet be done.

The problem of the origin of Glaze is discussed in the concluding section. Here it suffices to say that Glaze I makes a seemingly sudden appearance at Pecos in fully developed form, the vessels having, in the opinion of Miss Shepard, in which I concur, been brought to the village by trade. Once there, they set the style for the decorated pottery of the next three centuries. Our review must accordingly begin with Glaze I, even though it was not, apparently, a Pecos product.

The shapes of Rio Grande vessels were always of the simplest. Particularly is this true of the Pecos Glazes. Only bowls and ollas were in favor, and during the whole Glaze period they varied extraordinarily little from the canons established by Glaze I. The bowl was, throughout, a round bottomed, sub-hemispherical container averaging about 11 inches in diameter, which changed significantly, from period to period, only in the contour of the rim, which underwent the series of relatively slight, but remarkably consistent, modifications that render this part of the vessel so valuable as a chronological criterion. The Glaze I bowl rim was direct and unthickened. The lip then became heavier than the vessel wall (Glaze II); its flat surface gradually canted inward to produce a bevel; and the lower part of the bevel

grew into a thickening, the "carina" of Mera[1] (Glaze III), which rounded and spread and faded into the general thickening of Glaze IV and through this to the definitely "clubby" rim of Glaze V. Toward the end there was a lessening of weight, the rim grew taller, and tended to recurve gently outward (Glaze VI), thus foreshadowing the high recurved rims of Modern bowls.

The olla, like the bowl, was round-bottomed, although at the very close of the Glaze period the Pecos potters hit upon, or learned from some outside source, the simple device of indenting the base to provide greater stability by means of a broader bearing surface.[2] Ollas were small, probably never much over 12 inches high. The earliest were round-bodied with a plain rim surmounting a low, almost cylindrical neck. Later the shoulder became more pronounced, eventually protuberant. As the body drew outward, the angle between it and the neck grew less acute until, in the latest specimens, it is difficult to determine where the one ends and the other begins. The rim, while never varying as much as did that of the bowl, passed through several phases, the lip tending first to bevel inward, then to flare. Never was there any thickening.

In decoration, as well as in vessel form, the makers of Glaze ware were markedly conservative, more so than has probably been suggested by the type descriptions, in which differences, rather than similarities, have naturally been emphasized. When one views the entire series it becomes evident that the total change that took place during the three centuries of this style's existence was not only remarkably small, but was also brought about by modification of features either already present in the earliest type, or of very early introduction, more than by the invention of new devices.

The ensuing recapitulation of the life-history of Glaze decoration is based upon study of the bowls, because these vessels far outnumber all others in the collections of whole pieces and of sherds; and also because it seems evident that from beginning to end bowls set the style for the ornamentation of ollas and shouldered bowls.

The as yet unknown makers of Glaze I supplied Pecos potters with a strong and simple decorative system, in which the problem of preliminary layout was solved in the most obvious manner by use of a single horizontal band, encircling the interior of the bowl or the shoulder of the olla. The band was subdivided, again in the most obvious way, by cutting it into four panels; and the panels, in turn, were occupied by two alternating designs, to produce the simplest of rhythms.

Glaze I is characterized by accuracy of line and by emphasis upon detail. This elegance of rendering was made possible by the tractability of the paint, which evidently flowed well from the brush and which neither spread nor ran on firing. But very thin lines, such as could be drawn with the pigments favored by the Black-

[1] Mera, 1933.

[2] One wonders, in this connection, why potters in all parts of the world were so slow to adopt flat bottoms. Rounded or conical vessels might perhaps have been best suited for cooking on open fires, but for general household purposes and for the serving of food a flat lower surface would surely have been advantageous. That the same result was attained in various apparently less obvious ways, as by pot-rests, ring-stand bases, recurved bottoms, and tripod or tetrapod supports, would seem to indicate that the moulding, or perhaps the firing, of flat-bottomed containers presented difficulties.

on-white potters, were apparently not practicable with glaze mixtures, nor would they have achieved maximum effectiveness upon the dark red backgrounds employed by the earliest glaze decorators. These factors saved Glaze I patterns from becoming over-refined, cluttered, and "finicky." There is very little difference between the decoration of Glaze I Red and that of Glaze I Yellow, the type which became the more popular toward the end of the period, save that in the latter advantage seems to have been taken of the greater contrastiness of paint and background to produce designs somewhat richer in detail.

The succeeding type, Glaze II, was an inferior imitation of Glaze I. It was light-slipped, the brief experimentation with darker shades that resulted in Local Glaze I Red having been notably unsuccessful. Its decoration is, by Glaze I standards, both crude and simple. This I originally believed to be a degeneration, but in the light of Miss Shepard's findings it is with greater likelihood to be interpreted as due to the Pecos potters being unpracticed in the painting of designs and to their having had to work in a poorly understood, unreliable medium. Be that as it may, the accuracy of Glaze I brushwork was lost; the heavy upper framer which, by contrast, lent distinction to the fine, true lines of the pattern proper, became thinner; at the same time the pattern lines grew heavier. In the inner treatment of the panels it is easy to see the coarsening influence of lack of confidence in the paint. Delicate work being impossible, more and more emphasis was thrown on such large elements as filled corners; some Glaze II bands contain, in fact, little else. The stepped line disappeared, checkerboarding also; the stalked key, that hallmark of Glaze I, is absent; oblique keys were sloppily executed. Originality in treatment might have brought new virility to Glaze II, but the patterns were slavishly copied from the earlier type, and we find the same bands with alternating four-paneled arrangement, the same methods of panel division, the same oblique planning of the panels themselves.

Although decorative art in Glaze had, at Pecos, so unpromising a beginning, the work of the later part of this initial period of copying foreshadowed, in two particulars, the general improvement which was soon to come. In the first place, the potters were learning to compound a glaze paint which would acquire real luster on firing; and in the second, they began to enrich the outsides of their bowls and the necks of their ollas with bold red figures outlined in glaze. These improvements were, in the one case, presumably not due to local inventiveness in the matter of paint mixing; nor, in the other, to artistic initiative on the part of Pecos women; such novices, if our conception of the course of ceramic events in the Rio Grande be correct, could hardly be expected to have been, at this time, either technological leaders or innovators in the matter of ornament. Hence both the better glaze and the handsome new red figures should probably be attributed to influence from other villages. They resulted in the development of the notably better decorated type which we have called Glaze III.

Glaze III is characterized by a striving for striking effects. The slips average whiter than in Glaze II; the glaze, though still far from uniformly lustrous, often attained a satisfactory sheen; and the red exterior figures, contrasting sharply with the light backgrounds, rendered the vessels almost gaudily polychrome. The syntax

of design remained, however, practically unchanged; bands still predominated; they were, as before, cut into four panels; and the panels themselves contained alternating devices which were either the same as those of Glaze II, or were only slightly modified from Glaze II prototypes. There was still further elimination of detail, due, it would seem, to realization that spreading of the glaze would nullify any attempt to produce fine lines or involved arrangements.

Just as features characteristic of Glaze III made their first appearance in Glaze II, so Glaze III contains the germs of decorative practices which reached full development in Glaze IV. Among these are: multiple lines instead of a single open space for dividing panels; the placing of single figures in panels; the sporadic use of red in the interiors of bowls; and, most radical departure from earlier standards, the occasional treatment of the bowl interior as a field for an all-over pattern in glaze-bordered red.

The above-listed features, and others less obvious, but which become evident upon close analysis of the decorations, indicate that there was a local transition between Glaze III and Glaze IV, a thing which I had formerly doubted because of certain striking differences between the two types. These lie in the use of red slips for Glaze IV, in a great improvement in brushwork, and in a marked falling off in the popularity of the band, with corresponding emphasis upon all-over patterns. Such seemingly radical changes naturally suggest a wave of influence from without. But, as Miss Shepard's technological studies show that the bulk of Glaze IV was made at Pecos, it is evident that the postulated external stimulus was not due to any such wholesale importation of manufactured vessels as apparently took place in Glaze I. Regarding what actually happened, one can at present do no more than guess. The general rise in ceramic ability, expressed in the moulding of vessels, in quality of glaze, accuracy of brushwork, and boldness and freedom of designing, can hardly be considered a Pecos efflorescence; it might have been caused by an influx of new clans, or by imitation of the work of more gifted potters at nearby villages. Not until information is available as to what was happening at this time in other parts of the Upper Rio Grande can this problem be solved.

The outstanding characteristic of Glaze IV is its red slip, which forms a pleasingly sober background for the darker reds of the glaze-outlined figures on bowl exteriors and for the interior all-over patterns. Bands, as has been said, lost favor; in paneling they were bound by less rigid conventions; and they were sometimes drawn on the exteriors of bowls, a practice which first made its appearance in Glaze III, but which is utterly at variance with earlier canons. Concurrently with this lessening of formalism there was an elaboration of figures by addition of enriching details.

The red slips of Glaze IV did not long persist. Miss Shepard believes that suitable slip clays of this color were probably not to be had in the Pecos Valley. At all events, there was a return to light backgrounds, a change which took place while decoration was still holding to Glaze IV standards. The typical Glaze V color scheme, red on yellowish-white, a combination of more subdued shades than those of Glaze III, thus came into use sooner than did the renewed simplification of design

that marks full Glaze V. The transition between the two types was a relatively gradual one.

In Glaze V the potters of Pecos for the first time broke away from the main current of Rio Grande ceramic evolution. Until then they had probably been mere imitators or, at best, participants in a general movement. But now they struck out on a path of their own, while most other towns, according to what little we know of the rest of the area, apparently continued to develop their Glaze pottery along lines established in Glaze IV. The Pecos departure was brought about by emphasis upon glaze paint *per se*. Attempt was evidently made to heighten the luster of the glaze, and in so doing control over it in firing was lost. The paint ran and spread to such an extent that fine-line designs were spoiled. The decorators accordingly ceased all attempt to produce them and concentrated upon large, striking figures. The interior band was replaced by a single red, glaze-bordered stripe, the exterior key patterns, so typical of Glazes III and IV, were abandoned in favor of *awanyus*, key-tails, and birds, the latter simplified renderings of earlier avian forms.

The last surely locally-made type, Late Glaze V, bears decorations which are even further simplified.

Fig. 226. Glaze V. Fragment of handled olla with red slip and white, glaze-bordered decoration. (Width of sherd at base, 8½ inches)

UNUSUAL FORMS IN GLAZE AND OTHER NON-CULINARY WARES

In the matter of vessel shapes, the Pecos potters were even more unimaginative, more loath to depart from customary standards, than they were in decoration. During our many seasons of digging we sorted literally tons of potsherds and saved every fragment of a vessel which differed in any particular from the monotonously regular run of bowls, shouldered bowls, and ollas. Yet our whole collection of such material barely fills three museum trays. Of unbroken pieces, there are, of course, even fewer. All this material is described in the present section, rather than under the headings of the various Glazes, because it is often difficult or impossible to place any given specimen chronologically. Most of the few period assignments attempted are, indeed, tentative, being based more often upon quality of slip or nature of decoration than upon stratigraphic evidence, for, due to the extreme rarity of these aberrants, they naturally very seldom turned up in the tests or in the always relatively small beds of unmixed débris. Furthermore, a certain number of the specimens are without much question ceremonial and therefore might well have been kept in use for many years before finding their way into the rubbish heaps or being buried in a cache.

OLLAS WITH HANDLES

All handles broken from their parent vessels and all sherds bearing handles were saved. The collection contains about eighty such specimens. Forty of these are parts of smallish, red-slipped, relatively high-necked ollas, apparently somewhat similar in shape to the normal ollas of middle Glaze V (see fig. 208, *a*, *b*). Uncertainty as to form and size is due to the extremely fragmentary nature of the material. Most of the pieces consist of the handle alone, or of the handle and an insignificant part of the wall. Only the specimen illustrated in figure 226 retains a reasonably large proportion of the original vessel. But careful study of the sherds indicates that many others certainly, and the rest probably, were broken from analogous containers.

The handles are cylindrical, $\frac{5}{16}$ to $\frac{1}{2}$ inch in thickness, and span an area never large enough to permit the passage of a finger (fig. 227, *f-j*, *s*). They are set vertically, the upper attachment about $\frac{1}{2}$ inch below the rim. Attachment, as is evidenced by many of the sherds, was accomplished by the "rivet" method, i.e., two holes were punched in the still plastic wall for the reception of the ends of the separately prepared handle (see fig. 279, *e*). In some cases the holes were made slightly larger within than without and the end of the handle was widened by pressure to fill the extra space; most commonly, however, the hole is of uniform bore. The inner surface was always so carefully smoothed after attachment that, save in section, no trace of the work can be seen.[1]

[1] For description of the making and attachment of handles at San Ildefonso, see Guthe, 1925, p. 50 and pl. 17, *b*. At that pueblo only horizontal handles were riveted, vertical ones, which receive less strain, being merely welded to the vessel wall. All Pecos handles seem to have been riveted.

Fig. 227. Glaze ware handles. (Width of *t* at rim, $2\frac{5}{8}$ inches)

The red slip covers the outer part and the sides of each handle. When there is relatively large clearance the inner surface is also slipped. Decoration is almost always by a few transverse or oblique daubs of glaze upon the outer surface. Whether there was one handle or, as seems more likely, a pair per olla is not determinable.

Our single large fragment (fig. 226) is from an olla with diameter of about 9½ inches, height probably 7 inches. There are, as I have said, forty handles from vessels of this general type. All are slipped red and several of them, including the sherd illustrated, are attached to parts of the vessel wall bearing decoration in glaze-bordered white paint. Only eight similar handles emanate from ollas with light slip (fig. 227, *k-o*). There is stratigraphic evidence that some of the handled ollas were made during the Glaze V period; and not one of the sherds seems, judging from the appearance of slip and glaze, to be earlier. It should be noted that red bowls with white decoration are more often found in Glaze V than in any other stratum.

OTHER VESSELS WITH HANDLES

Certain small, doubtless ceremonial, vessels provided with handles and a few handles that may be from canteens are described elsewhere (p. 271). There remain to be mentioned thirty-odd miscellaneous fragments. Of most of these handles little can be said, save that with two flat exceptions they are cylindrical. Some, being fairly long, seem to have spanned spaces wide enough to accommodate one to three fingers. As they appear to have been set vertically, they may have belonged to pitcher-like containers, although there is no evidence that there was ever made at Pecos anything resembling the pitchers of the San Juan and Upper Gila. The only local specimens even remotely suggesting that type are illustrated in figure 249, *h*, *i*. The former is of Plain Black ware, the latter is an undecorated, light-slipped piece from a pure middle Glaze V deposit in Kiva 12.

There are two or three very heavy handles whose angle of attachment makes them look as if they had been placed horizontally at the shoulders of ollas, raking slightly downward in the Mesa Verde manner.[1] Each of two fragments of small round-bodied vessels with somewhat flaring rims (period uncertain) bears a single horizontal handle arching an opening about the size of a lead-pencil (fig. 227, *p*). True handles for bowls, such as are seen in Black-on-white (cf. Vol. I, fig. 4, *k*), do not occur, although there are two fragments of Glaze III bowls each of which has a little vertically-pierced lug just under the rim on the exterior.

Zoömorphic handles are very seldom found on any form of Pueblo pottery, ancient or modern, save in the Upper Gila region. Only seven specimens came to light at Pecos. Three of these are from Glaze vessels (fig. 228): the bird head shown at *d;* the small bird figure (*c*); and a little quadruped which has lost its head and tail. The latter is from a Glaze I Yellow bowl; the others are broken from vessels of unknown form—their period is also uncertain. The larger quadruped (*e*) once formed part of a culinary vessel (see p. 338, and fig. 278, *g*). The two heads *a* and *b* are of gray pottery with decoration in matte black paint.

[1] See Nordenskiold, 1893, pl. XXXII, 3; Kidder, 1924, fig. 9, *g*.

Finally, we have a dozen one-attachment handles: short, curved protuberances from the walls of ollas (fig. 227, *a-e*). Presumably they turned downward, but where they were placed, or whether there was more than one per vessel, is not known. All seem to be Glaze V.

In closing this section, the extreme rarity of all forms of handles should once more be emphasized by recalling the fact that the few examples above described are

Fig. 228. Zoömorphic handles. *a*, *b:* Bird heads, dull paint ware. *c*, *d:* Bird and bird head with glaze decoration, period uncertain. *e:* Quadruped (?), culinary ware. *f:* Small quadruped from exterior of a Glaze I Yellow bowl. (1/1)

all that were recovered from among the enormous numbers of sherds that came to light at Pecos.

SMALL OLLA-SHAPED VESSELS

These are more or less faithful copies, in miniature, of the standard ollas in use at any given period. Their reduced size has resulted in the crowding of decoration and the frequent elimination of neck patterns, for the painters did not refine their

brushwork to correspond to the limited fields to be ornamented. Examples run from 2 inches or so in height (sherds) up to the 5½-inch jar shown in figure 229, *d*. There is no evidence that little ollas of this sort were made in Glaze I Red times; a single sherd may be Glaze I Yellow, another Glaze II; a large majority are Glaze III (fig. 229, *b*, *c*); a few are surely Glaze IV (*d*); the example at *a* and one sherd are Glaze V.

Fig. 229. Glaze ware. Small olla-shaped vessels. *a:* Glaze V. *b*, *c:* Glaze III. *d:* Glaze IV. (Greatest diam. of *d*, 8¼ inches)

"NUBBIN" VESSELS

I can think of no better term than the above for certain small pots of which only fragments came to light (fig. 230). They are characterized by mammiform[1] protuberances equally spaced in a single horizontal series at, or somewhat above, the point of the vessel's greatest diameter. The bosses are usually abrupt swellings of the wall, apparently made by pressure from the interior while the clay was still plastic; only very small ones (as fig. 231, *c*) are solid. There seem to have been from five to as many as twelve or fourteen per vessel. Each boss is almost always ringed with concentric circles of glaze, the summit often bearing a dot. A pair of lines or a red, glaze-bordered stripe about the orifice generally forms the only other decoration.

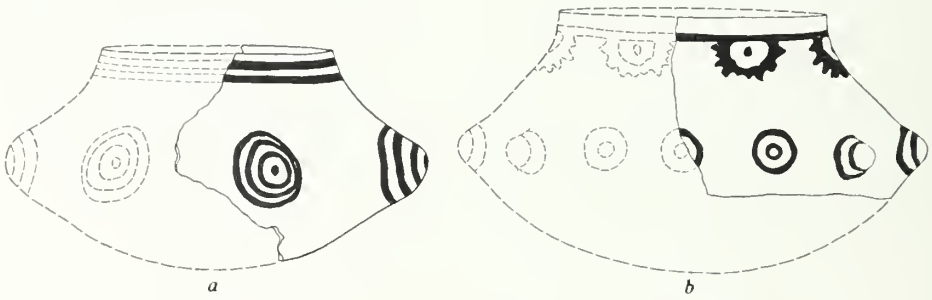


Fig. 230. Glaze ware. "Nubbin" vessels, probably Glaze III. (2/5)

Two body shapes are represented: one rather shallow in proportion to its height, with a low standing rim (fig. 230, *a*); the other, somewhat rarer, with more nearly spherical body, unmodified rim and higher-set "nubbins" (fig. 231, *e*).

Although there is no certain stratigraphic evidence for assigning these vessels to Glaze III, the quality of the light-colored slip which covers the exterior of most of them, the glaze, and such decoration as they bear, all seem to indicate that the majority were made during that period. Two fragments (fig. 231, *b*, *d*) have an earlier look; *b*, indeed, might well be Glaze I Yellow. It is possible that some of the few which bear red slip should be assigned to Glaze IV; almost surely none are Glaze V. Their extreme rarity is proved by the fact that only forty-three fragments were found during the field examination of many hundreds of thousands of sherds.

[1] The first specimens found I took to be breasts broken from female figurines. There is no evidence, however, that human effigy vases were ever made at Pecos.

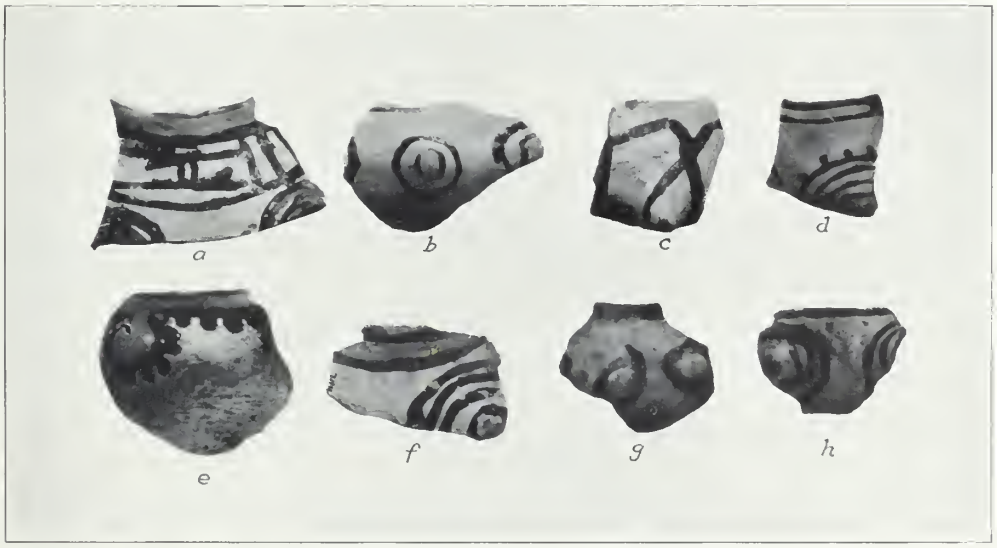


Fig. 231. Glaze ware. Fragments of "nubbin" vessels. *d:* Probably Glaze I Yellow, the rest probably Glaze III. (Width of *a* at rim, $2\frac{1}{8}$ inches)

STIRRUP POTS

This is an excessively rare form, not only at Pecos but throughout the Southwest. It is characterized by a full, round body of perhaps two-quart (2.2 litres) capacity, from the upper surface of which rise two tubular pipes uniting to form an upright mouthpiece or spout (fig. 232). The drawing is from our only sizeable fragment. Although undecorated, the piece can safely be assigned to Glaze V. Two other bits were found, one of them surely Glaze II or III. Nelson has recovered a few whole pieces from the Galisteo Basin; these run from Glaze I Yellow to Glaze III; they are in the American Museum of Natural History. Stirrup pots, though evidently never common, were thus in use for a considerable length of time. Their function is un-

Fig. 232. Light-slipped ware, probably Glaze V. Fragment of "stirrup-vase"; restoration of body on basis of specimens from Galisteo Basin in American Museum of Natural History. (1/8)

known. The bifurcated spout, however, offers a convenient grip for carrying and, although I have not had opportunity to experiment, I should think that, when tipped up with the tubes in a vertical plane, water would pour readily from the lower one, air entering through the upper, thus somewhat obviating the choking that takes place in a single passage.

CANTEENS

The almost total absence, during the Glaze periods, of an approximately quart-size container with small orifice and two handles or lugs for the attachment of a carrying cord, in other words of the form which in the Southwest is usually, and probably correctly, identified as a canteen, can only be explained by supposing that gourds, or possibly leather bottles, were used on the many occasions when it must

have been necessary to carry limited amounts of drinking water to the fields or on extended trips for hunting and trading.[1] Local Black-on-white ware produces a very few specimens which might have served as canteens (Vol. I, p. 48, fig. 4, *f*, *h*, *j*). These are of the generally spherical shape which is characteristic of all Southwestern canteens prior to the Regressive Pueblo period. The more practical mammiform canteen, flat on one side, bulging on the other, seems not to make its appearance until late in that period, perhaps, indeed, not before European contact. At all events, there is no good evidence of this type at Pecos until Glaze V, although one sherd might possibly be Glaze IV. Our material is limited to ten fragments, only five of which can be identified with reasonable certainty. Three are small loop handles set edgewise on bits of body that seem to have the proper curve (i.e., with one side flat, the other bulging); two are cylindrical necks ½ inch high with ¾-inch orifice, also upon sherds of the correct contour. None of the fragments is large enough to give any hint as to size or as to the relation between orifice and handles. An unbroken canteen, apparently Glaze V, was ploughed up in the early 1920's by a Mexican rancher near the foot of the Pecos mesa about five miles northwest of the pueblo. Its shape was much like that of the Plain Red specimen illustrated in figure 247, *c*, but it was about twice as capacious. Its discovery underground, far from any contemporaneous ruin and near what must have been a much-travelled pass between the upper valley of the Pecos and the country to the west, leads one to wonder if it might not have been cached, like the gourds mentioned by Castañeda, to await the return of a hunter or traveller.

"SALT DISH" BOWL

There is a fragment of a little cup, 1 inch wide, ¾ of an inch deep and once apparently about 2 inches long, which had been moulded on the exterior of the rim of a Glaze IV bowl. No other Glaze ware example came to light, but several Biscuit B bowls from Pecos and elsewhere are provided with analogous appendages (see Vol. I, p. 105 and fig. 57, *e*, *f*). It is possible that the vertically perforated lugs found on the exterior of two Glaze III sherds (see p. 265) are also from "salt dish" bowls, as a similar lug is sometimes placed opposite the cup on Biscuit specimens (Vol. I, fig. 57, *e*). Our Glaze fragment, however, lacks one end, so that one cannot tell whether or not it had a perforated extension, as does the cup of some of the Biscuit bowls.

DOUBLE-CURVE BOWLS

This is an extremely rare form. Only two whole examples and two sherds have been discovered at Pecos. The photograph (fig. 233) makes clear the shape, which is likewise found in Biscuit B (see Vol. I, figs. 53, *a*; 57, *c*). One bowl (fig. 233, *b*) and one sherd should probably be classed, on the basis of their decoration, as late Glaze

[1] Castañeda, speaking of the Hopi in 1540, says: "when they travel across this region themselves they take with them women laden with water in gourds, and bury the gourds of water along the way to use when they return." (Winship, 1896, p. 490.)

II, although their rims are direct and unthickened; the fragment has a rim of the type shown in figure 68, *j;* it might be either Glaze II or III. The second whole bowl (fig. 233, *a*) is evidently an early specimen. The exterior and the lower part of the interior bear yellowish white slip; the flaring upper part of the interior is red. The exterior decoration is in the Glaze I manner. The bowl, however, has a non-Pecos look and I am inclined to believe it a trade piece. I do not know of similar vessels from other Rio Grande Glaze sites.

Fig. 233. Glaze ware. Double-curve bowls. *a:* An early specimen, perhaps contemporaneous with late Glaze I; it is probably not of local manufacture. *b:* Glaze II; this piece reproduced by courtesy of Mr. Wm. H. Claflin, Jr. (Diam. of *b*, $8\frac{1}{4}$ inches)

SOUP-PLATES

In discussion of Modern painted ware (Vol. I, p. 136) these were called "plates," but because of the general use of that term by Middle American archaeologists to describe extremely shallow, really plate-like, utensils, I have returned to the catch-word designation used in the field-notes.

The specimens in question are rarely found, at Pecos, in Modern painted ware. We have a single sherd from a Plain Black example; a complete one of Plain Red (fig. 249, *b*); and ten slipped red and decorated with glaze. All the rest of the approximately two hundred fragments saved are light slipped. Paste, slip, and glaze are like those of Glaze V. Stratigraphic evidence, too, serves to assign most of them to that period. They are first found in full Glaze V strata, none occurring in earlier horizons.[1]

Fig. 234. Glaze V. Soup plates. This form was first made in Glaze V, and continued in limited use during the Modern period. (1/4)

It is to be supposed, because of their sudden appearance in deposits of historic date, and because there is no local or even regional prototype, that they are imitations of European forms. How late they persisted in common use is uncertain, for the late deposits are both thin and badly eroded. But their relative scarcity in wares of the Modern group (Modern painted, Plain Red, and Plain Black) makes it seem probable that the form lost popularity after the close of the Glaze V period.

Measurements. The light slipped soup plates ranged from 6 to 11 inches in diameter (fig. 234). Most of the specimens, from calculations based on rim-sherds, were in the 7- to 8-inch class, few exceeding the latter diameter. The depth seems to have been very little more or less than 2 inches, irrespective of the diameter. *Diameter-depth index* accordingly varies from .18 to .33, with the commonest index at about .23. The flaring *rim* is flat or very gently curving. From a rounded lip it slopes slightly downward for from 3/4 of an inch to 1 inch, at which point there is a rounded (fig. 234, *a*) or almost angular (*b*) dip as the vessel wall falls away to the flat bottom. The rim is usually a trifle heavier than the wall and bottom, which are 3/16 to 1/4 of an inch thick.

Decoration is confined to the flaring rim. It almost invariably consists of sets of three parallel, close-set dashes of glaze running inward from the lip to the inner edge

[1] The statement in Vol. I (p. 136) that they were "relatively common in Glaze VI" is an error. Closer study of the material indicates that the great majority, perhaps all, are Glaze V.

of the flare. Sets of two and four dashes occur. We have fragments with as much as half the perimeter of the rim, but in no case is more than one set of dashes present. I infer, accordingly, that a single set was the rule. There are naturally many sherds which have no decoration. There are a very few fragments whose rims are ornamented with a one-line glaze zigzag, which apparently encircled the plate. The rare red slipped form seems also to have been provided with the conventional three dashes.

Fig. 235. Glaze ware. Small cup-shaped vessel. Slip and glaze are similar to those of Glaze IV, but the decoration is in the Glaze V manner. (1/2)

CUP-LIKE VESSELS

About thirty sherds seem to be parts of small cup-shaped utensils with flat bottoms, and straight or slightly flaring walls. Some at least had a single vertical handle. The wares are Glazes III to V. In the lot are eight pieces which belong to a well-defined type. Although the material is miserably fragmentary, one can determine that the originals were beautifully made. Figure 235 is a restored drawing of the largest sherd. Characteristic features of this and of the other seven examples are: flat base, basal flange, vertical wall, horizontally protruding rim. Finish, slip, and glaze are excellent. There is no evidence that there were handles. The five best pieces are certainly Glaze IV; three are without much question Glaze V.

PRAYER-MEAL BOWLS

At the modern pueblos, small pottery vessels, often rectangular in shape and sometimes bearing terraced projections from the rim, are used for various ceremonial purposes, especially to hold the sacred meal which plays so important a rôle in Pueblo religious practices. There were unearthed at Pecos a few sherds of containers of similar forms, and therefore presumably analogous in function. Of these pieces, the most certainly identifiable as ceremonial is a 9-inch bowl in fragmentary condition, from Room 372. Enough was recovered to permit confident restoration of the shape (fig. 236, *b*). From opposite sides of the rim rise small terraced projections.[1]

[1] The method used by the potters of San Ildefonso for making such terraces is described by Guthe (1925, p. 48, fig. 7).

Directly below each terrace, on the inside of the bowl, was a spread-eagle bird, of one of which a considerable part remains (fig. 236, *c*); the other, to judge from a bit of the head and one wing, was its duplicate. How the figures terminated, and whether or not the interior bottom of the bowl was ornamented, cannot be told. The exterior (*a*) bears large terraces from which zigzag arrows extend to the rim. I suspect, because the decoration runs so low, that it covered the whole exterior bottom, as it does on a Modern painted ceremonial bowl illustrated in Vol. I, fig. 101. Arrows on zigzag shafts, it should be noted, are also present on that specimen.

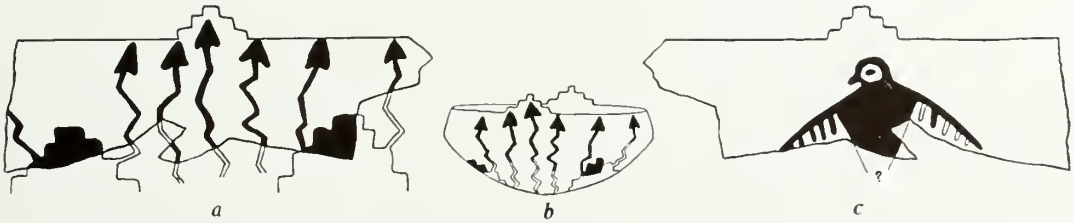


Fig. 236. Glaze ware of uncertain period. Ceremonial (?) bowl. Exterior (*a*) and interior (*c*) of a large fragment. (1/3). A sherd from the opposite side, bearing part of a second terrace, makes possible the restoration at *b*.

As may be seen in the drawing (fig. 236, *b*), the outline of the piece under discussion recalls that of a Glaze IV or V bowl. The slightly thickened rim is in the Glaze IV manner; but the well smoothed slip, which varies from a greenish slate color to a dirty, yellow-white, has its closest parallels in certain Glaze V sherds poorly ventilated in firing. The yellow-green, imperfectly taken, and somewhat scaled glaze, might be of any period from Glaze II onward. The specimen was found with other Glaze V material, but this is not conclusive evidence of contemporary manufacture, for ceremonial vessels, being naturally much less subject to breakage than ordinary household utensils, doubtless often remained in use for a long time. On the whole, however, I am inclined tentatively to assign the present object to Glaze V, because no surely identifiable example of rim-terrace has come to light in earlier strata, while there are terraced fragments which almost certainly belong to Glaze V or subsequent periods. Furthermore, the elements of the exterior decoration have obvious analogies to the "lightning arrows" and terraces of Pecos pipes of late manufacture.[1]

Four additional fragments of terraced projections, presumably from bowl rims, were recovered (fig. 283, *d-g*). One of them (*g*) is of Plain Red ware; another (*e*), which is also undecorated, has yellowish white slip on the outside, red slip within; the remaining two (*d*, *f*) are obviously Glaze V, the larger is slipped red on the inside. A sherd with staggered nipple-like protuberances on the rim is unique; it is part of a flat-bottomed object whose original shape is a mystery (Glaze V or VI).

[1] See Kidder, 1932, p. 179.

Made of Plain Red ware are a considerable number of fragments of small rectangular containers, some of which are perhaps ceremonial (see p. 290 and fig. 247, *d*). Such forms, in Glaze, are exceedingly rare. We have one bit of a double specimen; it is probably Glaze IV. There is also a corner of a plain rectangular piece; this might be Glaze V. The little glaze decorated dish shown in figure 244, *b*, having been found in the grave of a two-year old baby (Skel. 923), should probably be considered a toy.

PROBLEMATICAL SPECIMENS

We have twenty or thirty pieces of oddly shaped Glaze containers whose original forms can hardly even be surmised. Three of them might be from small twin bowls with a hollow bar connecting them; one or two cone-shaped bits are possibly the tail ends of duck-pots (cf. fig. 278, *e*), though there is no other evidence that this form was ever made in Glaze. Whether all, or any, of the above were ceremonial, whether they were the result of mere virtuosity, or whether they were made for toys, is unknown. The whole collection of such unidentifiable material will be held at Andover. Future finds of more complete examples may permit restoration; or some of the Pecos specimens may eventually prove to be representative of types characteristic of other villages.

CANDLESTICKS

Although they bear no glaze decoration, there are included in this section about a hundred fragmentary objects made of paste similar to, though somewhat coarser than, that of Glaze V vessels. The pallid yellowish-white slip with which most of them are covered is also not unlike that of Glaze V.

The accompanying illustrations (figs. 237, 238) show the hollow cylindrical shaft, the flanges, and the plain or slightly flanged-lipped (fig. 238, *b*) terminal socket, which was apparently always separated from the shaft by a septum (fig. 237, *a'*). At about the level of the septum there was, in some cases at least, a somewhat wider flange (fig. 237, *a*, *a'*) turned upward as if to catch dripping wax. We have no complete specimen nor, queerly enough, any piece which clearly indicates the nature of the base, but certain sherds of the same sort of clay and bearing identical slip indicate a spreading foot (fig. 237, *a*). The foot must of course have been hollow. Otherwise the shaft, closed above by the septum, would have burst on firing, unless it had been pierced by lateral holes, of which there is no evidence.

The longest piece (fig. 237, *a*) measures 7 inches; its shaft averages 1¼ inches in diameter. There are fragments of shafts as thick as 1¾ inches; the slimmest, a solid one, has a diameter of ⅞ of an inch. The hollow shafts were made by ring-building, the rings being left unobliterated on the interior (fig. 237, *e*). They overlap $\frac{3}{16}$ to $\frac{5}{16}$ of an inch. The end of each ring slightly overlaps its beginning. The wall averages ¼ of an inch thick. The flanges were luted to the exterior of the shaft (fig. 237, *e*). The slip, which ends at the lip of the terminal socket, was occasionally, though not often, worked over with the rubbing stone. A few specimens are of rather poorly smoothed redware (fig. 237, *c*).

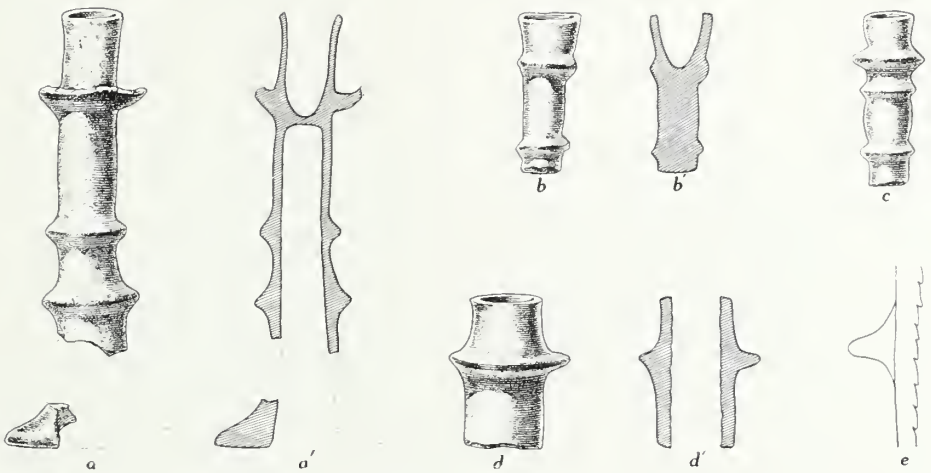


Fig. 237. Candlesticks (?). *a*, *b*, *d:* Drawings and sections of fragments of upper parts (*a*, *b*) and shaft (*d*) of light-slipped specimens. The structural rings, which apparently remain unobliterated throughout the interior of the shaft of *a*, have not been reproduced. *c:* Top of red-slipped, solid-shafted candlestick. *e:* Diagrammatic section of fragment of shaft, showing unobliterated structural rings on interior and method of luting encircling ridges on exterior. (Length of upper part of *a*, 7 inches; total height conjectural)

Fig. 238. Fragments of candlesticks. (Height of *a*, $3\frac{1}{4}$ inches)

The identification is based on the resemblance of these objects to European candlesticks. It is to be supposed that they were used for religious purposes. Very few, however, came to light near the ruins of the Mission, almost all having been found in the rubbish below the North Quadrangle. I have wondered if they might perhaps have been made for household shrines, in imitation of the metal candlesticks which probably graced the Mission. All are of historic date. They appear first in Glaze V refuse and are also found in association with Modern painted pottery, though none of them carries the easily recognizable crackled Modern slip.

SMALL CEREMONIAL VESSELS

In the course of the excavations at Pecos there were recovered about forty little containers whose specialized shape and decoration indicate that they were not ordinary household utensils. The places in which they were found, as well as the objects which accompanied some of them, render it certain that they were made and used for cult purposes. The specimens in question (figs. 239 to 245) are characterized by very small size and by possessing, with only two exceptions (figs. 242, *d*; 243, *b*), two tiny handles or two perforations near the rim, as if for suspension by cords.[1]

All were taken from deposits of post-Spanish date, twenty-six of them from close under the surface of the North Quadrangle plaza.[2] One group of six (fig. 239) was accompanied by three thin, round slabs of sandstone, 6 to 9½ inches in diameter, each perforated at the centre by a small drilled hole (see Kidder, 1932, p. 98, fig. 74, *b*). With each of two groups of five (figs. 240, 241) was a single slab of the same sort. A single pot (fig. 243, *b*) was found close to a painted "altar-slab" (Kidder, 1932, p. 96, fig. 93). Unaccompanied by other objects were a pair (fig. 242, *c*, *d*) and five singles (figs. 242, *a*, *b*, *e*; 243, *c*; 244, *f*). Close together, but not in direct association, were three (fig. 243, *g*, *i*, *j*); they lay in the top stratum of an open area just south of the North Quadrangle. Three came from kivas. Two of these (fig. 243, *f*, *h*) formed part of caches in sub-floor bins in Kiva 16; one (fig. 245, *a*) came to light during the excavation of Kiva 6, but as it turned up during the removal of back-dirt it was impossible to tell whether it had been deep in the fill or lay, like so many of the others, close under the surface. Lastly, in Room 30, which yielded a great deal of other ceremonial material,[3] were six vessels, three of which are illustrated in figure 244, *g-i*. Eight specimens, three of which (fig. 243, *a*, *d*, *e*) are closely similar to the above, and five of which (fig. 244, *a-e*) are here listed because of their small size, were found with burials, in rooms, or in general digging (for their provenience see captions).

The photographs and drawings render sufficiently clear the general nature of these interesting little vessels. Most of them are well made. Their decoration, how-

[1] At Pueblo Blanco in the Galisteo Basin, Nelson excavated a room which contained an anthropomorphic stone idol, concretions, petrified wood, and eight little vessels similar to those here described (Nelson, 1914, pp. 90-92, fig. 12).

[2] The exact location of the various finds, and notes on the archaeological conditions which proved the late date of their interment, will appear in the concluding volume of this series.

[3] Kidder, 1924, p. 26.

Fig. 239. Ceremonial vessels. Six specimens found cached with three circular, perforated sandstone slabs close below the surface of the North Quadrangle plaza. *a:* Red slip, glaze decoration. *b-d:* Light slip, glaze decoration. *e, f:* Well-smoothed reddish brown ware, undecorated. (1/2)

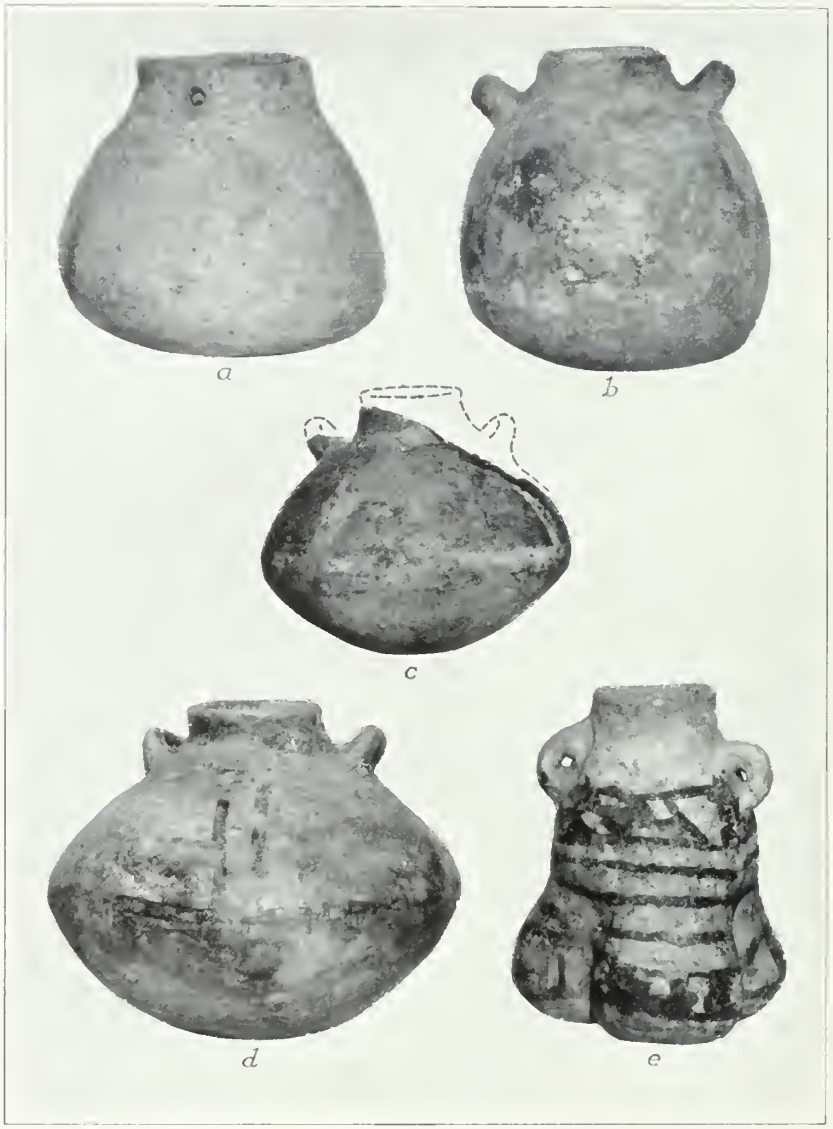


Fig. 240. Ceremonial vessels. Five specimens found cached near those shown in fig. 239. Accompanied by a single circular, perforated sandstone slab. *a:* Light slip, undecorated; two perforations on opposite sides below rim. *b-d:* Light slip, glaze decoration. *e:* Black-on-white ware (for drawing, see fig. 245, *b*). (1/2)

Fig. 241. Ceremonial vessels. Five specimens found cached near those shown in figs. 239, 240. Accompanied by a single perforated slab. *a:* Well-smoothed reddish brown ware. *b:* Gray slip, undecorated. *c:* Yellowish slip, glaze decoration. *d:* Gray slip, glaze decoration. *e:* Black-on-white ware. (1/2)

Fig. 242. Ceremonial vessels. Five specimens found close below surface of North Quadrangle plaza; *c* and *d* lay together, *a*, *b*, *e* separately. *a:* Light slip, badly fire-clouded, glaze decoration. Handles like those of fig. 239, *f* have been broken away and suspension provided for by two drilled holes close to the rim. *b:* Biscuit (A?). *c:* Light slip, glaze decoration. *d:* Red slip, glaze decoration. *e:* Well-smoothed reddish brown ware. (1/2)

Fig. 243. Ceremonial vessels. *a:* Black-on-white ware; with Skel. 1619. *b:* Rough-surfaced dark ware; with painted sandstone slab in plaza of North Quadrangle. *c:* Light slip, glaze decoration; from plaza of North Quadrangle. *d:* Black-on-white ware; eastern rubbish heap. *e:* Dark red slip, glaze decoration, Glaze IV period (?); Skel. 1671. *f:* Light slip, glaze decoration; Kiva 16. *g:* Black-on-white (?) ware; south of North Quadrangle. *h:* Scraped but unsmoothed dark ware; Kiva 16. *i:* Red slip, glaze decoration; south of North Quadrangle. *j:* Well-smoothed reddish brown ware; south of North Quadrangle. (1/2)

Fig. 244. Ceremonial vessels and others. *a-e:* Pieces perhaps not ceremonial. *a:* Glaze III (?), light slip; encircling red, glaze-bordered stripe; from east rubbish heap. *b:* Light slip, glaze decoration; Skel. 923. *c:* Heavy, unsmoothed dark ware; Room 47. *d:* Rough dark ware; west rubbish heap. *e:* Black-on-white (?) ware; Room E-V. *f-i:* Ceremonial vessels. *f:* Black-on-white (?) ware; plaza of North Quadrangle. *g:* Black-on-white ware; Room 30. *h:* Early Glaze V (?), light slip, glaze decoration; Room 30. *i:* Modern painted ware, base slipped red; Room 30. (1/2)

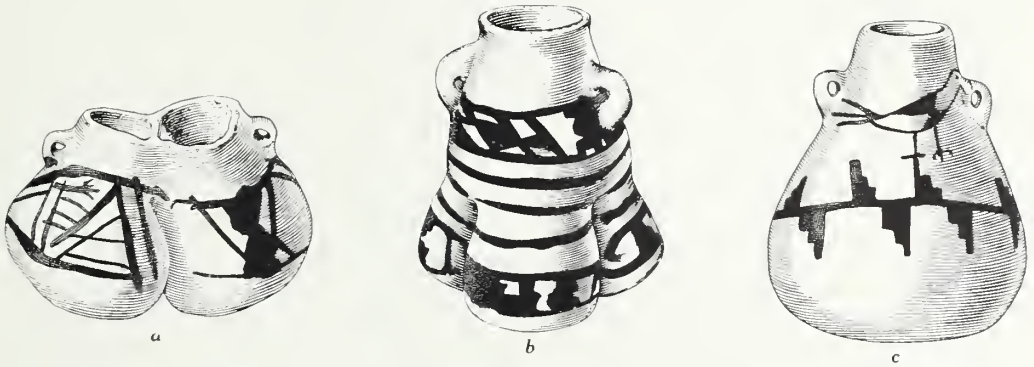


Fig. 245. Ceremonial vessels. *a:* Black-on-white ware; Kiva 6. *b:* Black-on-white ware; plaza of North Quadrangle (for photograph, see fig. 240, *e*.) *c:* Black-on-white (?) ware; general digging. (1/2)

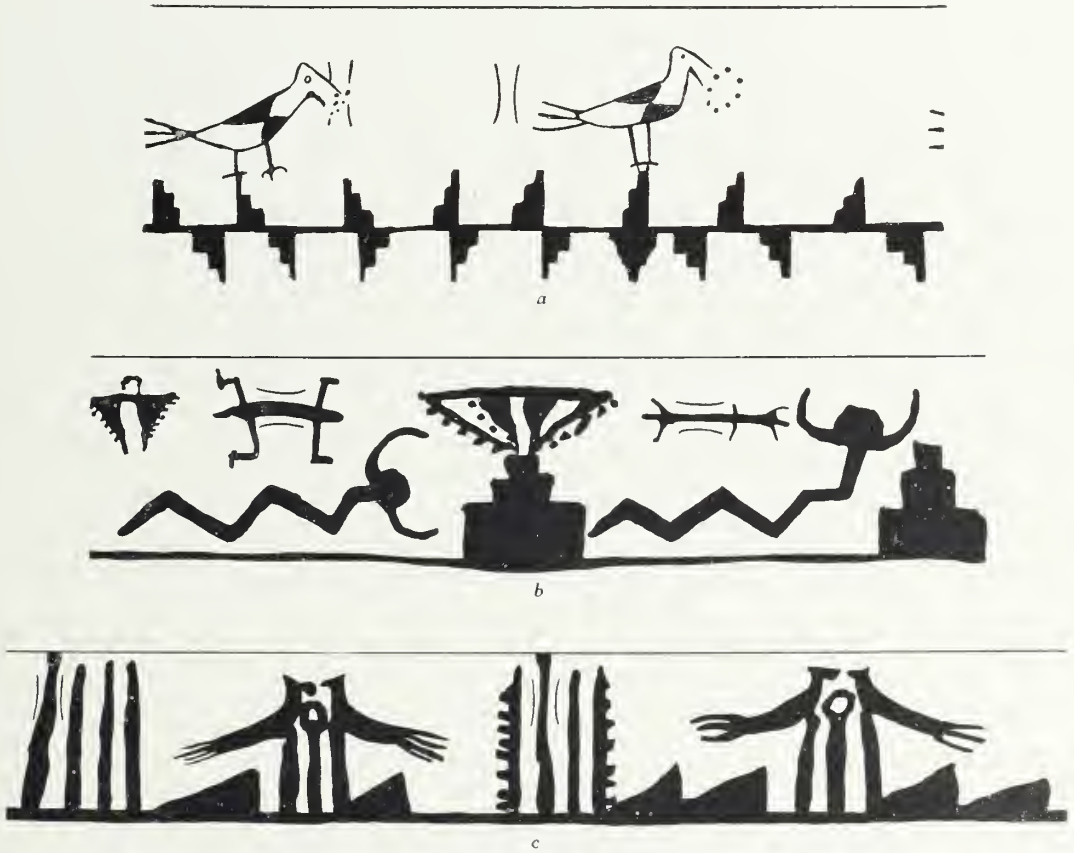


Fig. 246. Ceremonial vessels. Decorations; the position of the handles is indicated by paired lines. For shape of the Black-on-white vessel bearing *a*, see fig. 245, *c;* for that of the Biscuit vessel bearing *b*, see fig. 242, *b;* for that of the Black-on-white (?) vessel bearing *c*, see fig. 243, *g*. (1/2)

ever, is quite uniformly careless. Those of Black-on-white ware (figs. 240, *e*; 241, *e*; 243, *d*; 244, *f*, *g*; 245, *a*, *c*) usually bear geometric ornament; those of Glaze ware run to stepped motifs (fig. 241, *d*—a terraced figure), the commonest arrangement being pairs of keys set back-to-back (figs. 239, *c*, *d*; 242, *c*; 243, *f*, *i*). Terraced figures appear on the single Biscuit (fig. 242, *b*) and Modern painted (fig. 244, *i*) examples. A number are undecorated, some slipped, some unslipped (see captions).

The reader will have noted that the wares represented by the small ceremonial vessels run the whole gamut of Pecos ceramics from Black-on-white to Modern painted. Yet, as has been said above, they were all found in deposits of the historic period, some at least as late as 1700. This of course shows that most of them were in use for a long time, the Black-on-white specimens perhaps as much as four hundred years. But few, queerly enough, are very severely worn or battered. Doubtless they were treasured clan heirlooms, which were relatively seldom called into active service, and always carefully handled. I suspect, indeed, that some of the vessels were copies, archaistic reproductions so to speak, of older ones which had been broken. For example, those of Black-on-white ware illustrated in figures 243, *d* and *g* have an "off color" look; while the little red piece at figure 242, *d* bears a decoration of very early type (Glaze I, certainly not later than Glaze II), but the color and quality of its slip, and the form of its rim, convey the impression that it might well have been made in Glaze IV times.

UNDECORATED SMOOTH WARES[1]

During almost the whole period of occupancy of the Pecos region by Pueblo people there were in use but two sorts of pottery: smooth-surfaced decorated wares and more or less rough-surfaced culinary wares. Toward the end, however, there appeared vessels with smooth finish but without decoration of any sort. The new group consisted of two wares: Plain Red and Plain Black. They began to be made late in Glaze V and remained in fashion until the abandonment of the pueblo.

PLAIN RED

Although we have nearly thirty pieces, they are almost all regrettably fragmentary. The reason for this is, of course, that the ware did not come into use until after the Pecos had given up the practice of burying pottery with the dead. Such specimens as were found came from rubbish in abandoned rooms and could therefore seldom be recovered complete. But the sherd collection is large.

GENERAL CHARACTERISTICS

In the field and in the first volume of the present work this ware was called Polished Red.[2] It seems best, however, to revert to Plain Red, the term used in the first publication upon Pecos pottery,[3] because, while the vessels are perhaps somewhat better finished than is the run of the decorated wares, and although some of them even attain a moderate degree of luster, they are on the average not highly burnished. True polishing is, indeed, only found at Pecos upon the tall necked ollas of Modern painted ware.[4]

Most Plain Red vessels appear to be slipped, although it is sometimes difficult to distinguish between an added coat and the naturally red-burning paste. The slip is a thin layer which seems never to crackle or flake. Finish, as has been said, is good, but a striking luster was never attained. The marks of the smoothing stone are always visible, running vaguely horizontally in the usual Pecos manner. They do not, however, as in Plain Red wares from some other parts of the Southwest, produce an ornamental texturing of the surface.[5]

VESSEL SHAPES

The bowl is the standard vessel. It occurs in two forms: high rimmed and plain rimmed. There are also soup-plates and small rectangular vessels. We collected a single canteen and sherds of a few others. Ollas, which are very common in Plain

[1] For Miss Shepard's technological notes on these wares, see pp. 541-544.
[2] Kidder, 1931, p. 131.
[3] Kidder, M. A. and A. V., 1917, p. 338.
[4] See Kidder, 1931, pp. 132, 136; frontispiece.
[5] Gila Redware, Gladwin, W. J. and H. S., 1930.

Black, fail, queerly enough, to appear. In the field I assigned to Plain Red the many polished red olla sherds which emanated from late deposits, and included them in the 1917 description of that ware. It was noted even then, however, that they were much better finished than the bowls.[1] Careful recheck of the material fails to disclose a single fragment from the shoulder of a red olla; all our pieces are from necks and bottoms. It is therefore reasonably certain that they are parts of Modern painted ollas, whose necks and bottoms are highly polished and whose decoration is confined to a narrow zone at the shoulder.[2]

BOWLS

High rimmed bowls (figs. 247, *a*, *e*, *h*; 248, *a-h*; 249, *c-e*) are the most characteristic Plain Red forms. They resemble Glaze VI and Modern painted bowls (cf. figs. 222, 223; and Vol. I, fig. 84, *c*) in having a high rim gently recurved outward. The greatest diameter is normally at the lip. The bottoms are sometimes, but not always, a trifle flattened. Modeling is not good, rims being frequently irregular, both in elevation and in profile; some bowls are more or less lop-sided. Red slip usually covers the whole piece, inside and out; the exterior bottom of large bowls is sometimes left unslipped. *Measurements* of the whole pieces and calculations based on sherds show a diameter range of 8 to 14 inches, with depths of 3¾ to over 7½ inches. The small bowls (fig. 247, *a*, *e*) are relatively shallow; their *orifice-depth index* being .40 to .45. For the large bowls this index (calculated from sherds) seems to run as high as .54 (see fig. 247, *h*). *Capacities* of the large bowls are not determinable, because of the fragmentary condition of the specimens. The evidently rather common, deep 12- to 14-inch bowl must have held upwards of 6 dry quarts (6.6 litres). An 8- and a 9-inch bowl contain 1 and 1¾ dry quarts (1.1 and nearly 2 litres) respectively. The *rim* (fig. 248, *a-h*) of the high rimmed Plain Red bowl is similar to that of the Glaze VI bowl, although it tends to be somewhat more widely flaring (cf. fig. 223). Only in the larger, deeper bowls (as fig. 247, *h*) does the rim approach the vertical. No matter what its inclination, however, it is gently recurved outward, unthickened, and round-lipped. The *thickness* of the bowl wall is 3/16 to ¼ of an inch.

Plain rimmed bowls (figs. 247, *f*, *g*, *i*; 248, *i*, *j*; 249, *f*) are, on the evidence of the sherds, much less common than the high rimmed type. They are also less uniform in shape. *Measurements:* Most examples are small, 5 to 7 or 8 inches in diameter, with flat bottom and sides that have little curve (fig. 247, *f*, *g*); there are sherds of more nearly hemispherical pieces. Large, deeper bowls (fig. 247, *i*—this piece has a calculated diameter of 12 inches) also have flattened bottom, but the sides are rounded rather than straight. *Orifice-depth indices* vary widely; those of the small bowls illustrated in figure 247, *f* and *g* are: .47 and .37 respectively; that of the large bowl (*i*) is nearly .50. *Capacities* of the larger pieces cannot be measured; the little ones hold from ¾ to 1 dry quart (¾ to 1.1 litres). *Rims* of both large and small plain rimmed bowls are direct, the vessel wall continuing unmodified to the rounded lip (248, *i*, *j*). Slip, when present, usually covers all surfaces. The exterior bottom of large bowls is generally unslipped. There are also sherds of 9- to 10-inch bowls with a

[1] Kidder, M. A. and A. V., 1917, p. 338

[2] Kidder, 1931, frontispiece.

Fig. 247. Plain Red ware. *a, e, h:* High rimmed bowls. *f, g, i:* Plain rimmed bowls. *b:* Soup plate. *c:* Canteen. *d:* Rectangular bowl. (1/6)

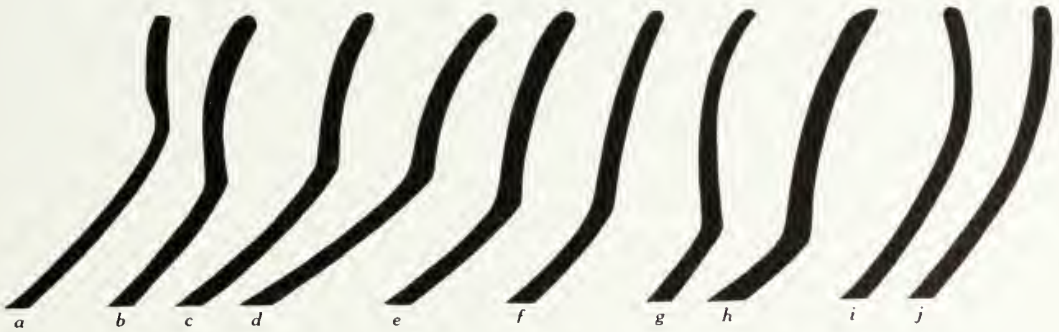


Fig. 248. Plain Red ware. Bowl rims. *a-h:* High rimmed bowls. *i, j:* Plain rimmed bowls. (1/2)

horizontal band of well polished slip, which begins on the lip and covers the upper 1½ to 2 inches of the exterior. The whole interior is in the bare paste, carefully smoothed. Its color is like that of the smoothed paste of Modern painted bowls.[1]

SOUP PLATES

According to sherd counts, these were of about the same frequency as plain rimmed bowls. As the two restorable pieces (figs. 247, *b*; 249, *b*) indicate, there is considerable variability both in size and in proportions. Diameters run from 4 to 11 inches, 7- to 9-inch pieces being standard. All are shallow; *diameter-depth indices* would appear to have been from .25 to .35; the specimen shown in figure 247, *b*, whose index is .41, seems to be deeper than usual. All are alike in possessing a relatively straight *rim* which flares widely, terminating in a rounded lip. The rim may be practically horizontal (fig. 249, *b*), but is more often set at an angle of from 10 to 30°. Slip covers the entire piece.

RECTANGULAR BOWLS

We have fragments of about twenty small four-sided Plain Red bowls ranging in length from 2½ to 4 inches, in width from 1½ to 3 inches, and in depth from 1 to 2½ inches. In the majority of cases the sides rise perpendicularly from a flat base. A few sherds, however, are from pieces of the peculiar shape shown in figure 247, *d*, in which the walls slant outward from the base, but turn upward to terminate almost vertically at the rim. Whether or not these rectangular bowls were ceremonial is uncertain; there is no specific evidence that they were.

CANTEENS

Canteens are represented by a single whole specimen (fig. 247, *c*) and a few handles which seem to have come from similar, but considerably larger, specimens. The complete canteen is of mammiform type, with flat back and bulging front. It holds about ⅔ of a dry quart (about .6 litres). Long use is indicated by the wearing off of the red slip from most of the back.

[1] For description of this type of surface, see Vol. I, p. 132.

PLAIN BLACK

Plain Black was somewhat less common than Plain Red, according to sherd counts from various late deposits. We have only a dozen pieces in even reasonably complete condition.

GENERAL CHARACTERISTICS

The dark color and the smooth surface of this ware serve to distinguish it from any other pottery found at Pecos. The finest pieces are almost jet black and display a polish almost equalling that of the red parts of high rimmed Modern painted ollas (Vol. I, frontispiece). Such perfection was, however, seldom attained, the average specimen being grayish-black and only moderately lustrous. But it is possible that moisture may have dulled, as it does in the case of the polished black pottery of modern Santa Clara and San Ildefonso, what was formerly a finer finish. The surfaces, at any rate, were carefully worked with the rubbing stone, faint marks of which are visible on even the smoothest pieces. Of a series of sherds examined by Miss Shepard, only one specimen proved to be slipped.

VESSEL SHAPES

Ollas hold almost exclusive predominance; bowls are very rare; there are a few pieces of peculiar shape, which were perhaps made for ceremonial use.

BOWLS

Early in the first season at Pecos we noticed that very few parts of Plain Black bowls were appearing and thereafter we saved all fragments encountered. Even so we have only thirty or forty specimens. They represent two sorts of bowls: small, plain rimmed, hemispherical pieces, 3 to 6 or 7 inches in diameter; and high rimmed bowls, 6 to 12 inches in diameter. Both are indistinguishable, save for color, from the corresponding Plain Red forms (fig. 247). The small, plain rimmed specimens outnumber those with high, outcurved rim more than four to one.

OLLAS

At least nine out of every ten Plain Black sherds found at Pecos are from ollas. The Plain Black olla seems, in fact, to have been the most popular non-culinary olla of its period as there were obviously more of them in use during the last century or so of the pueblo's occupancy than of the Modern painted variety. We were fortunate in recovering five restorable specimens, together with considerable parts of several others. These had, for the most part, been buried in rooms, their mouths flush with the floor, covered with a flat sandstone slab and used for storage.

The vessels are well moulded (figs. 250, 251). The shape is closely similar to that of the high necked Modern painted olla (Vol. I, frontispiece and fig. 87, *a*, *b*),

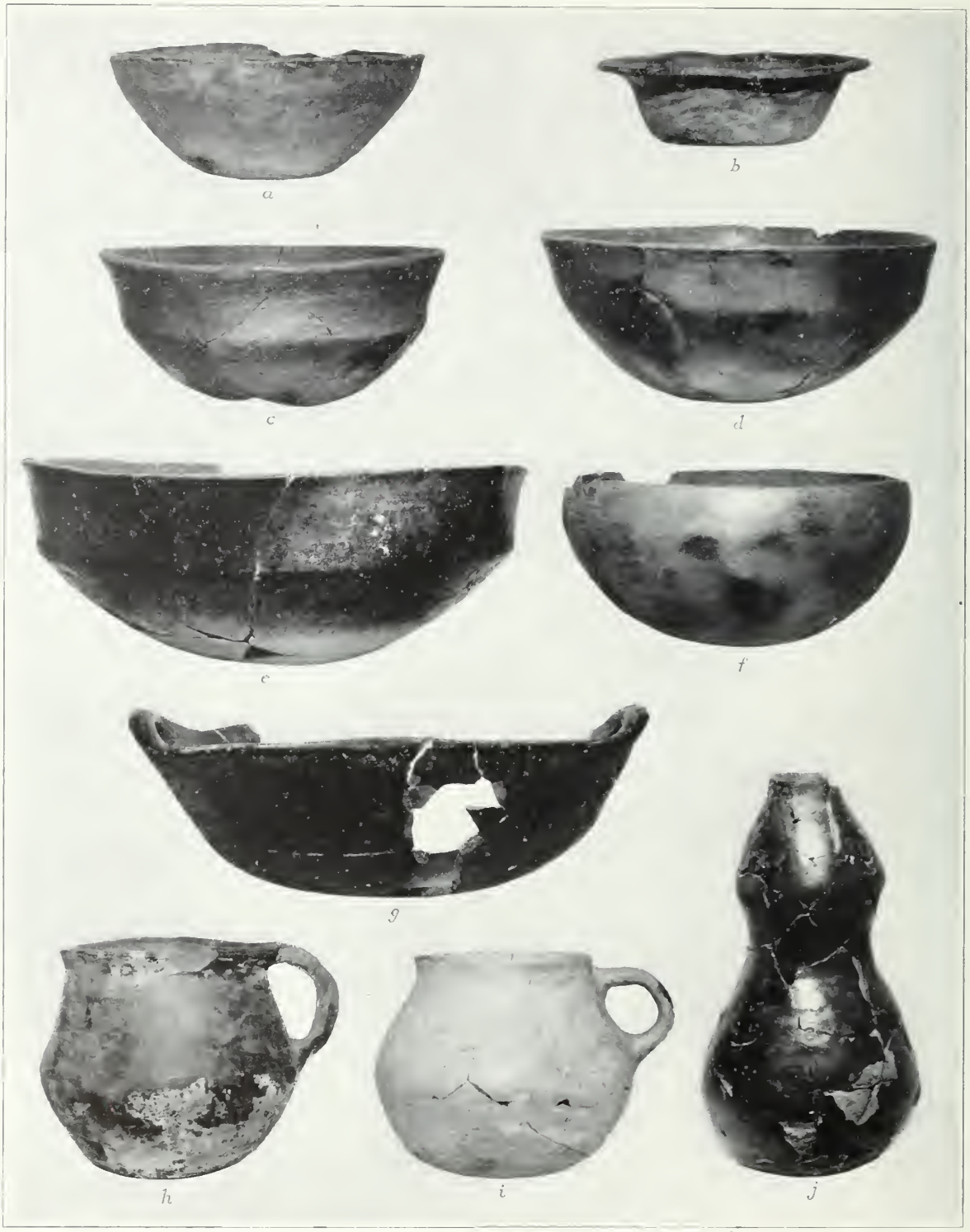


Fig. 249. Plain Red and Plain Black wares. *a-f:* Plain Red. *g*, *h*, *j:* Plain Black. *i:* Small pitcher with light colored slip and a single dot of glaze on the handle. It was found in a Glaze V deposit. (Diam. of *e*, $12\frac{1}{4}$ inches)

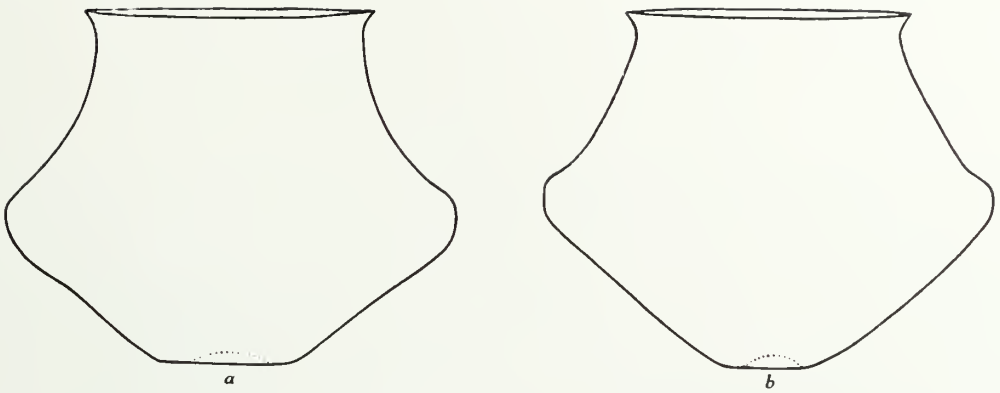


Fig. 250. Plain Black ware. Ollas. (1/6)

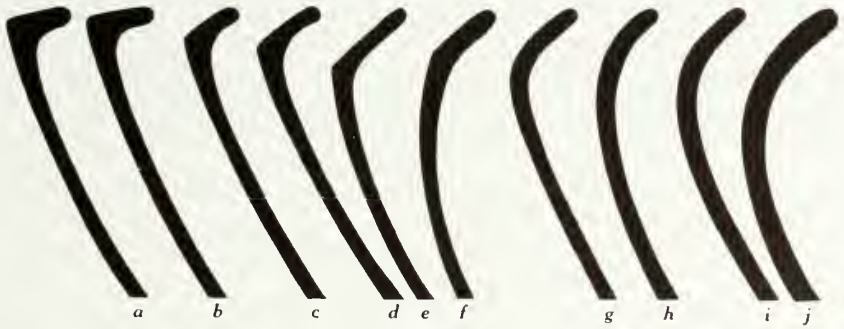


Fig. 251. Plain Black ware. Olla rims. (1/2)

and apparently much like that of the late Glaze V and Glaze VI ollas. The base is recurved, the shoulder bulging, relatively low-set, and of graceful contour. The *rim* varies from sharply (fig. 251, *a-d*) to gently outcurved (*g-j*). I think it likely that these changes may reflect the passage of time, for Plain Black ware was in use for well over a century. But there is no stratigraphic evidence to indicate which type is the earlier.

Measurements of whole pieces and sherds show the vessels to have been very uniform in size: height, 10 to 12 inches; diameter at shoulder 12 to 14 inches; diam-

Fig. 252. Plain Black ware. Ollas. (1/5)

eter of orifice, 8½ to 9½ inches. *Capacities* run from 10 to 12 dry quarts (11 to 13.2 litres).

Although none of our whole specimens is so treated, there are seven sherds from the shoulders of Plain Black ollas which are lightly but unmistakably indented as if by successive thumb-ball squeezings of the structural coil. The effect is not unlike that of hammered brass. The indentations, which are so shallow that they did not interfere with the action of the polishing stone, seem to have been confined to the protuberant shoulder; no neck sherd bears any sign of them.

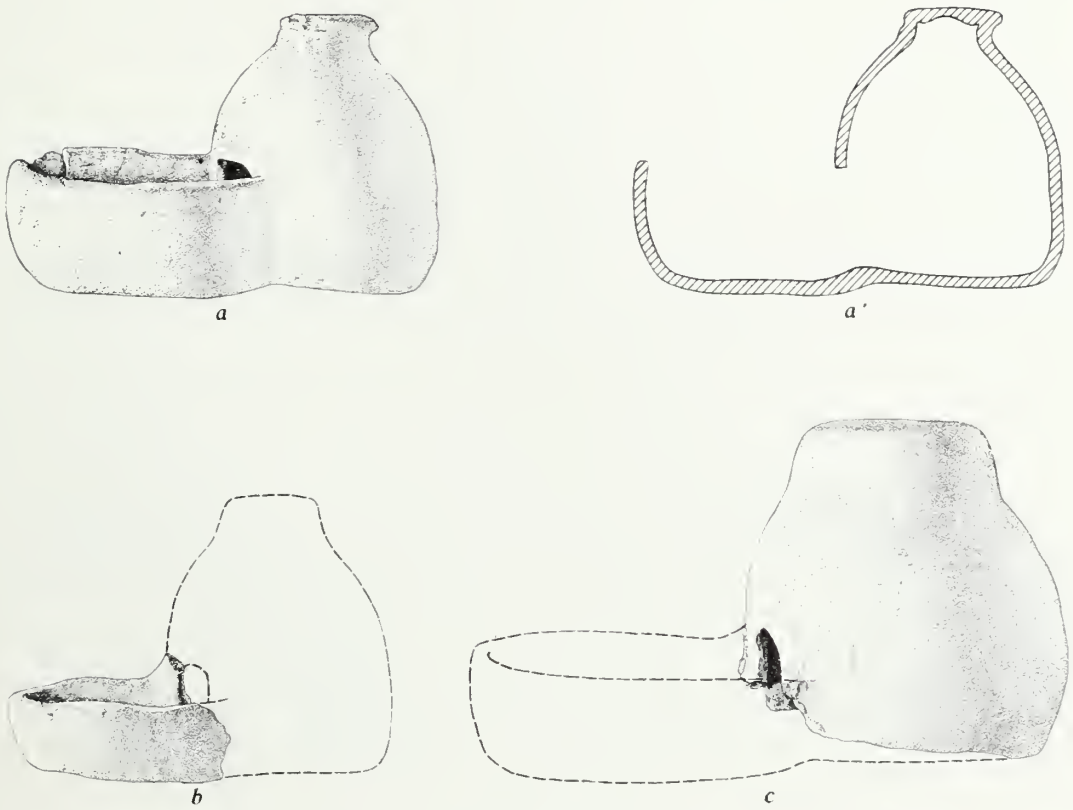


Fig. 253. Plain Black ware. Containers resembling water- or feed-troughs for poultry. *a*, *a'*: Drawing and section of the only complete specimen recovered. *b*, *c*: Restorations from fragments. (5/12)

"FEED-TROUGHS"

Of the little containers illustrated in figure 253 we have but five examples. The complete specimen (*a*) and the body (*c*) are of Plain Black ware; the tray (*b*) and two other fragments of trays are of brownish clay less carefully finished. As the drawings indicate, there is a beehive-shaped body with a flat top. In the lower part of one side of the body is a small rectangular or arched opening; in front of the opening there is a tray-like extension with low, vertical sides. The bottoms of all are flat; that of the whole piece (*a*) shows much wear.

These peculiar objects closely resemble the water- and feed-troughs used by modern poultrymen, which are replenished from the body as the contents of the tray is consumed. The Pecos pieces are not suitable for water, because the top of the opening comes above the level of the tray's sides at one point or another, thus giving

access to air and relieving the atmospheric pressure which would otherwise hold the water in the reservoir. But the apparatus functions well with dry materials, such as oats, a fresh supply trickling down as fast as the tray is depleted. Whether or not this clever device was actually used for feeding poultry is problematical. Nor can one be sure that it is a native invention, for the unbroken piece and the body were found in post-Columbian débris in Room E-II (there are no chronological data regarding the fragments of trays). The idea may, therefore, be Spanish, although I have no information regarding when such feeding-troughs came into use in Europe. At all events, the present specimens are of Indian manufacture. Nothing like them has apparently been found elsewhere in the Southwest. Following the archaeologist's usual practice in doubtful cases, one might class them as ceremonial; this identification receives some support from the fact that the two pieces from Room E-II were accompanied by several stone and shell beads.

VESSELS OF UNUSUAL FORM

Found in Room E-I, associated with the large Modern painted bowl illustrated in the frontispiece of Volume I, was a piece of unique form (fig. 249, *j*). Its height is 8 inches. The surface is well polished black, the reddish-brown paste is soft and crumbly. The flat bottom is slightly worn.

A second unusual piece is shown in figure 249, *g*. It is an oval, plain rimmed bowl of Plain Black ware, whose rim, at opposite points on the long axis, bears loop handles. There are sherds of two other bowls of similar form.

A small pitcher-like vessel (fig. 249, *h*) is of dark gray ware. Whether or not it should be classed as Plain Black is uncertain.

CULINARY WARES

A sharp distinction evidently existed in the minds of all Pueblo potters between vessels to be used for cooking and those for such general household purposes as the serving of food, the storage of supplies, and the carrying and holding of water. Containers of the latter sort were made of fine clay, were often brightly colored, were carefully smoothed, and as a rule were decorated. Kitchen ware, on the other hand, was usually fabricated from much coarser, or at least more coarsely tempered, clay; was preponderatingly dark in color, rough-surfaced, and never bore painted designs. Moreover, the shapes of the two kinds of vessels show consistent differences in any given ceramic complex.

Culinary ware possesses, of course, less esthetic interest than non-culinary pottery. Nor is it often of comparable archaeological utility, for its chronological and regional differences are relatively so inconspicuous that the student naturally turns, for preliminary determinations at least, to the painted wares, which are more strikingly variable and therefore more easily and quickly classifiable. Furthermore, cooking vessels were rarely employed as mortuary offerings; and as most excavators in the Southwest have devoted the greater part of their attention to cemeteries, these pots do not abound in museum collections. Even when dwellings are investigated, the cooking vessels, because of their great friability, are usually found so badly crushed that preservation and restoration are seldom attempted. It is accordingly not surprising that we know comparatively little about the culinary wares of the Southwest. Yet this generally neglected material amply repays close attention, for technologically it is extremely interesting; some varieties of cooking pots, indeed, are marvels of skillful clay working and all of them were admirably suited to the special function for which they were intended. Southwestern culinary ware is therefore of much importance for the comparative study of primitive ceramics. And when the details of its history have been worked out, we shall also be provided with a splendid example of the rise, diffusion, and decline of a highly specialized non-utilitarian technique, the practice of surface embellishment by manipulation of the structural coil. To understand the significance of this peculiar treatment requires discussion of the so-called "coiling" method of pottery making.

The simplest way to create a pot is to pinch and pat out a lump of clay with the fingers, or to line with clay the surface of a concave mould, such as a basket. But the finger process is only practicable for very small vessels, while open-form moulding can only produce bowl-shaped containers. To achieve larger pieces and to provide them with restricted orifices it is necessary to build upward from a prepared base (either made with the hands or pressed into a mould) by the addition of successive increments of clay. Although this may be done by placing lumps at intervals upon the edge, a much more effective way, and one which has been, and is still being, used by almost all peoples in the pre-wheel stage of pottery making, is to build by means of small rolls of clay sufficiently long to encircle the whole edge and thus raise it evenly. Such is the coiling method. The term is really a misnomer, for to coil means to manipulate cylindrically or spirally a continuous element. "Ring-building" would

more accurately describe the process as generally carried out, even in the Southwest. But in a part of that area, during later Developmental Pueblo times, it became customary to construct cooking vessels of a single strand of clay, which began at the base and, coiling upon itself spirally, continued to the orifice. The strand was of course not made to its full length before work began; it was added to from time to time; but so carefully was each new increment joined that it is seldom possible to perceive a junction. The coiling element may therefore properly be said to have been continuous.[1]

Spiral coiling began, as has been said, in the later part of the Developmental Pueblo period; the first appearance of this process supplied, in fact, one of the more or less arbitrary diagnostics which were used, in the Pecos nomenclature, to divide Pueblo II from Pueblo I. The earliest pottery of the Pueblo Plateau, that of the Basket Makers, was doubtless all ring-built; but the traces of the structural rings were usually so carefully removed that our only evidence that they were used is derived from observation of the interiors of certain vessels whose mouths were too small to allow the potter to smooth over their junctions. Eventually, however, it became customary to leave unobliterated the last few rings on the exterior of the neck of certain pieces with restricted orifice. This occurred at about the same time that other cultural changes, and particularly the apparent intrusion of a new physical stock, give justification for a classificational division between Modified Basket Maker and early Developmental Pueblo. That period, therefore, saw the beginning of *corrugation*, which, as its name implies, is the production of a horizontally ridged surface by leaving more or less unobliterated the junctions between structural rings or between the successive laps of coiled work.

The practice of corrugation became, for some unknown reason, popular and the structural coils were left unobliterated not only on the neck, but upon the whole body of the vessel. The history of this development has not yet been worked out in detail. Presumably the upper body was at first corrugated; the base, which was doubtless still being made in a concave mould, having remained plain. But two inventions, or rather one real invention and one adaptation of a structural feature, served to bring about important changes that set a style which endured for centuries and which led to the production of some of the most remarkable pottery ever made.

The structural feature just mentioned is the mark left in the clay by the potter when she pinches the roll to weld it firmly to the edge of the growing vessel. Such marks are inevitable, even in the relatively coarse ring-work of the modern Pueblos.[2]

[1] Regarding the above statement Miss Shepard comments: "I believe the two ends were welded in place on the pot. Coils as thin as those used in indented corrugated were delicate things to handle, and would be more easily rolled on a flat surface (as the Zuñi potters do) than in the hands; evenness of coil which is very important, could be much more easily attained in that way. Both hands would be needed to place the new coil on the edge of the pot, it could then be welded to the end of the old coil conveniently and no trace of the juncture left. But to hold the new coil with one hand, and weld to a protruding end without support would be difficult and endanger breaking the coil. Actually, I have found a good many examples of these welded ends."

[2] See the interior of the olla under construction figured by Guthe (1925, pl. 15, *a*).

They occur at greater or less intervals, according to the care with which the manipulator attaches her rolls, and are deeper or shallower in proportion to the force which she applies. Some potter, for it seems almost certain that this trick must have had its origin in the mind of a single individual, probably noticed that if her squeeze-marks were sharp and firm, and also regularly and closely spaced, they resulted, as coil was added to coil, in a pleasingly variegated surface. And so *indented corrugation* was begun. Whether this preceded or came after the development of *coiling* is as yet unknown. Presumably, however, coiling was an outgrowth of indenting, in order that the regular sequence of the indentations should not be interrupted. At all events, both techniques made an apparently almost simultaneous appearance. The next step, the corrugating of the entire surface of the vessel, including the base, was probably taken after the practice of indenting had become well established, for there was no necessity for the invention which rendered base-corrugation possible until potters had become keenly interested in the elaboration of their work; in other words, before they had begun consciously to play with the indented corrugated technique. This invention was the reversal of the mould and the building of the vessel's base upon its convex surface. This had to be done in order to extend effective corrugation to that part of the pot, for when laying rolls, or a continuous coil, in a concave mould it is naturally not possible to control the appearance of the exterior of the work. Yet, as I have said, corrugation, even indented corrugation, was carried to the very bottom of relatively early vessels. Such pieces must accordingly have been started upon the outer, convex surface of a mould. The continuous roll of clay, for by this time coiling, as distinguished from ring-building, had evidently become habitual, began at the centre of the base (fig. 293, *k*) and was carried around and around upon itself like a coil of rope, the indentations being produced by inward pressure against the mould rather than by thumb-and-finger squeezing. When, however, the coil reached the edge of the mould no further progress was possible until the so-far-completed pot-base had dried sufficiently to permit its removal from the exterior of the mould and its lodgement in the concave interior of the same, or of a similarly shaped, mould. Partial drying was imperative, not only for enough solidification to allow the base to hold its shape during transfer; but also to guard against crushing, and consequent spoiling, of the delicate edges of the corrugation. The shift from exterior to interior of the mould is postulable on technical grounds. That it actually took place is proved by flattening of the corrugations by pressure of the mould upon certain specimens insufficiently dried before turning; by marks of the mould's edge upon others; and by an occasional change in the style or the angle of impression of the indentations at the point where the work was recommenced.

Further building, after the transfer, had of course to be done freehand. There was no longer the support or the guidance of a mould. The coil was carried around and around, the vessel wall growing higher and higher, the indentations being now made by the thumb against the fingers. Just how this was done has not been exactly worked out, but so much material is available, and it carries so clearly every mark of the potter's hands (often including actual skin prints and the curving cuts of the nails) that one could, I am sure, reconstruct the entire process in the greatest detail,

working out, for example, the relative prevalence of right-and-left handedness.[1] It would be a study well worth making, for the indented corrugated technique, as developed by the Pueblos, led to a degree of skill in the manipulation of clay which has never been surpassed.[2]

The truth of the above statement becomes obvious if one consideres that corrugated pottery is built up by winding around and around on itself what amounts to a long, thin fillet of clay which, in well-made pieces, is continuous from its beginning at the bottom of the bessel to its termination at the rim; in some large jars this fillet attains a length of more than 200 feet. The laying up of this coil must in itself have been a very difficult matter, and when it is remembered that it was often also notched, indented, waved, or otherwise ornamentally modified during the building process, it will be realized how far removed was this technique from the first attempts of a nascent art. In the making of smooth-surfaced pottery any irregularity may be rubbed down or filled in, any fault of outline corrected by humoring the plastic walls into shape; in corrugated ware, however, no mistake could be corrected, and from beginning to end the coil must have been laid on with the sure hand and steady eye that could only have come from long practice, not only in the handling of clay, but in mixing it to exactly the proper consistency for this delicate work. It is no exaggeration to say that the construction of a large, ornamentally indented, corrugated olla required more skill than did any other form of handmade pottery that has ever been produced in ancient or modern times.[3]

Indented corrugation, as practised during the late Developmental and Great Pueblo periods constitutes one of the finest possible examples of that playing with technique, that virtuosity, that extraordinary devotion to pure craftsmanship, which develops from time to time among primitive peoples. For corrugating served, as far as one can see, no useful purpose whatever; no more than did, for example, the senselessly complex weaving of Basket Maker sandals. The sandals were invisible, their life was short; the cooking jar was quickly covered with soot, it was soon broken. Both objects played the humblest rôles. The mere pleasure of producing them, sheer satisfaction in perfectly accomplishing a supremely difficult task, must have actuated their makers.

It is interesting to trace the history of this remarkable corrugated technique. It seems logical to suppose that it had its origin in the San Juan drainage, for that area was without question the focal centre of the Modified Basket Maker, the culture which, ceramically at least, laid the foundations for Developmental Pueblo. And in

[1] Miss Shepard states: "My experience leads me to think that pinching with the left hand does not necessarily indicate left handedness. The use of the side of the left thumb when directed obliquely upward as in pinching a counterclockwise coil seems easy and natural to me although I am not ambidextrous."

[2] Since the above was written, Miss Shepard has made experimentally various types of indented corrugated vessels. Her results throw much light on the methods of corrugating and indenting (see pp. 552-561).

[3] Morris (1917, p. 24) first called attention to the difficulty of making corrugated pottery. His paper conclusively refuted the then widely held theory that corrugated wares were older and more primitive than smooth-surfaced pottery.

the latter period corrugation, as we have seen, first became a regular practice. Early Developmental Pueblo also centered in the San Juan, although there were extensions into the Little Colorado. The Hohokam obviously played no part either in the genesis or the development of the technique. Hohokam pottery, even if it ultimately prove, as some believe it will, to have been ancestral to that of the Basket Makers, shows no tendency toward corrugation at any stage of its long career; in fact, the paddle-and-anvil method of its manufacture prohibited such a treatment of the surfaces of vessels by obliterating the structural coils, not merely as a finishing process, but in the actual shaping of the walls.[1]

The simple, flat, ring-corrugating of the necks of early Developmental Pueblo pottery was succeeded, in the later part of that period, by coiled corrugation of the indented variety, covering, sooner or later, the entire vessel. This stage, the old Pueblo II, is at the moment imperfectly understood. It will prove, I believe, to have been a more or less irregular transition. Its characteristic small-village life will probably be found to have continued longer in some regions than in others. Be that as it may, and regardless of what it shall ultimately be decided to call them, the abundant small ruins of the San Juan that were intermediate in time between the early Developmental Pueblo sites and the more highly evolved communities which at present we assign to the Great Pueblo period, were the seat of an intensive and rich development of corrugated cooking wares. This pottery was technologically somewhat inferior, perhaps, to the corresponding ware of the Great Period; the vessels, from what little we know of them, seem to have been heavier-walled, less perfectly shaped, their capacity less standardized. But in the details of surface treatment, in manipulation of the coil, in the depth and boldness of the indentations, and in the variety of their application, the Pueblo II pots are outstanding. They are, indeed, exactly what one might expect from potters who, during a period of vigorous cultural growth, and unhampered by convention, were experimenting with a new and fascinating method of handling a responsive and plastic medium.

The Great Pueblo period, the time of the Pueblo Indian's greatest cultural vigor, is now thought to have lasted from about 1000 to about 1300 A.D. It is characterized by strong local specializations, both in the San Juan country and in those peripheral areas to which San Juan influence had already spread, or was then spreading. But these specializations seem to have been more markedly efflorescent in decorated pottery than in corrugated wares. It must be admitted that at the present time we know the painted vessels much better than the cook-pots, and there may have been distinctive local developments of which we are still ignorant, such as that which at this time produced the extraordinarily fine corrugated bowls of the Upper Gila. In general, however, it seems apparent that the making of corrugated pottery was becoming a more or less routine industry. Manipulative skill attained extraordinary heights, many of the Great Period jars of the San Juan having been marvels of accurate coiling, regular indenting, and symmetry of outline. Nevertheless, this very perfection, this standardization of workmanship, seems to presage the fall of the technique. It had reached, one imagines, the limit of its possibilities; and the

[1] Gifford, 1928.

potter's interests, thwarted of further outlet in that direction, may well have turned to the greater possibilities of painted decoration, particularly those offered by the new polychrome styles which, in the later part of the Great Period, were beginning to spread north and east from the Little Colorado. Black-on-white wares, which had hitherto always accompanied the corrugated, were also approaching the end of their long career.

The whole problem of ceramic change at this time is bound up with that of the fall of the northern communities, the abandonment of the San Juan, and the rise of new large groups on the Rio Grande and the Little Colorado. Those events mark the end of the Great Period. Black-on-white ware became extinct, corrugating degenerated more slowly. The latter process we shall be able to follow in our study of the cooking wares of Forked Lightning and Pecos. But before turning to the pottery of those sites, it may be pointed out that the persistence, after the disappearance of Black-on-white, of a debased form of corrugated may perhaps be a further indication of the growing lack of interest in it which I have postulated for the Great Period, my idea being that the making of corrugated ware had become, in the latter period, so routine a practice, so almost unconsciously performed a task, that it was less easily uprooted by calamitous events, or by the introduction of new styles, than was the production of this or that highly specialized local variety of decorated pottery.

CULINARY WARES OF FORKED LIGHTNING

The cooking pottery of Forked Lightning is particularly interesting because it represents a degenerative transition between the beautiful corrugated wares of the Developmental Pueblo and Great Pueblo periods and the plain-surfaced products characteristic of the Regressive and Historic periods. For the study of local pottery it is important in that it lies at the bottom, so to speak, of the Pecos culinary series, and in that it was probably more fully and directly ancentral to the later cooking pottery than was Forked Lightning Black-on-white to its decorated successors.

Unfortunately very few whole, or even partially restorable pieces were found. But large collections of sherds were made from general digging, from rooms, and from tests. There is thus available a great amount of evidence regarding the surface treatment of the vessels, but relatively little, and that mostly inferential, as to their sizes and shapes.

GENERAL CHARACTERISTICS

The ware, as found, is usually black, but there is good reason to suppose that this is mostly due to kitchen use and that before seeing service it was gray or brownish gray. Intense heat, as in the burning of a dwelling, turns it reddish brown. The interiors of all pieces are smoothly finished; exteriors are either corrugated, blind-corrugated, or plain. There are no examples of added plastic ornament or of incising.

CORRUGATED

The distinction between *Corrugated* and what will later be described as *Blind-corrugated* wares is that in the former the actual lines of junction between the coils

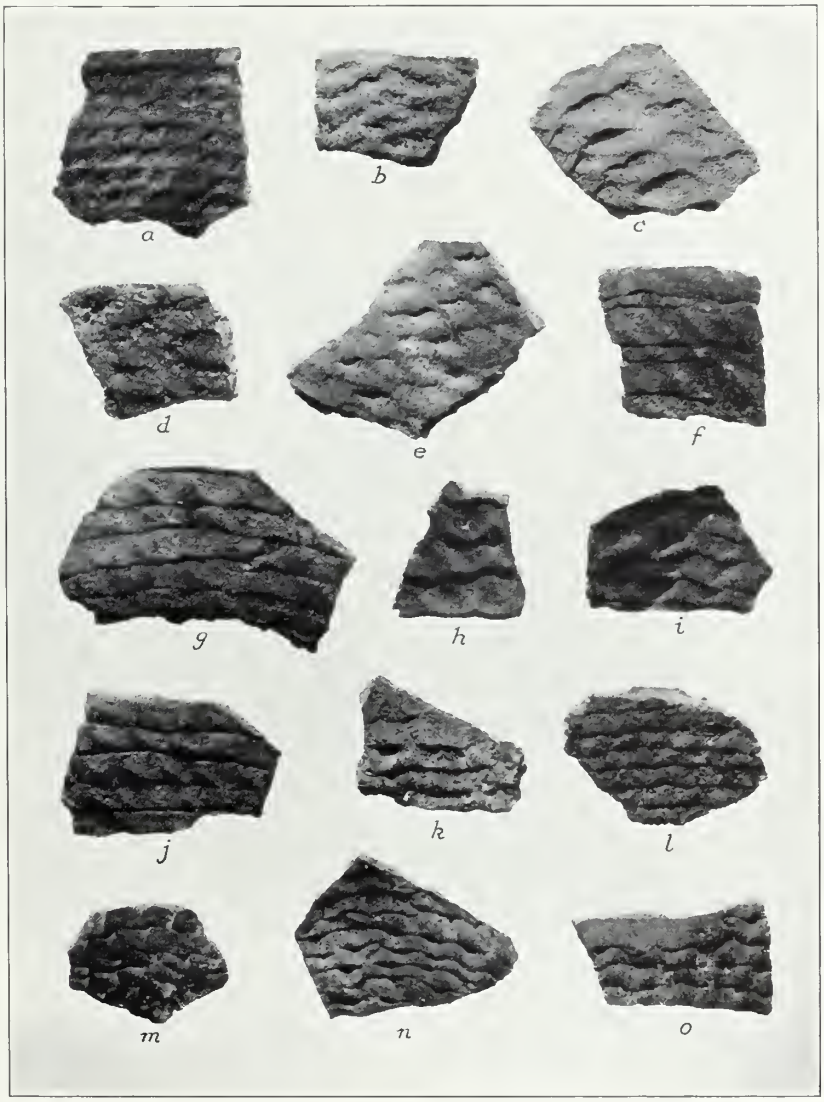


Fig. 254. Culinary ware. Stratigraphic series from Test D, Forked Lightning (oldest at bottom, most recent at top) showing change from sharply marked corrugation to blind corrugation. *a-e:* Indented Blind-Corrugated. *f-o:* Indented Corrugated. (Width of *g*, 3 1/8 inches)

are distinctly visible (fig. 254, *f-o*), whereas in blind-corrugated they are not (fig. 254, *a-e*). The commonest variety may be called *Indented Corrugated* (fig. 255). In this style the coils overlap, but they have been so well pressed down that horizontal ridging is slight. The pressing was accomplished by pinches at close intervals, the side of the end of the thumb having made the exterior contact, as is proved by many clear impressions showing the skin-ridges and occasionally the curving mark of the corner of the thumbnail; the fingers presumably provided the necessary support and counter-pressure on the interior.[1] In the Forked Lightning specimens the indentations made by the thumb are relatively broad and shallow in comparison, for example, to specimens from the Mesa Verde; this gives to each coil a gently undulating surface and often a somewhat wavy lower edge. The wave-like indentations of one coil are slightly offset from those of the coil below, but they are not deep enough, nor are they sufficiently varied in placement, to produce the strongly patterned effects seen in the more elaborate examples of indented corrugation from other regions. The Forked Lightning specimens are perhaps best described as lacking in elegance. The coils are irregular in width; the indentations are in general not carefully placed in relation to those of the coil below. The work is coarse, averaging three and one-half coil-laps to the inch; there are many cases of three, fewer of four, very few of five.

There are found at Forked Lightning a few sherds of a distinct type of corrugation, characterized by unindented coils which overlap each other strongly. This I call *Clapboard Corrugated* (fig. 256, *d*; for examples from Pecos, see fig. 261). The welding of the coils was done by even pressure, perhaps with the whole length of the side of the thumb's terminal joint, rather than by a series of more or less sharp pinches.[2] The result is a coil that is relatively straight-edged. The squeezing down of each coil has hollowed its upper part and forced up a rounded ridge along its lower edge.[3]

BLIND-CORRUGATED

The difference between this and true corrugated is that the junction lines between the coils have been obliterated. The surface has not, however, been sufficiently smoothed to destroy all trace of the coils, whose former presence is attested by faint horizontal ridges. The variety found at Forked Lightning may be called *Indented Blind-corrugated* (fig. 254, *a-e*), for the pinch marks, though sometimes very faint, are still unmistakably present, sometimes (*a*) strongly marked. I am at a loss to explain how the junction lines between could have been removed without at the same time destroying the indentations. One cannot discern the marks of a tool, nor of fingers; the surface seems not to have been scraped or wiped.[4]

[1] The position of the hands during this process is clearly shown by Guthe's photograph of a San Ildefonso potter at work (Guthe, 1925, pl. 12, *a*). See also Miss Shepard's study of corrugation (pp. 552-561).

[2] See also Miss Shepard's observations (p. 561).

[3] For a sectional drawing see Holmes, 1886, fig. 220, p. 278.

[4] Since the above was written, Miss Shepard has experimentally reproduced Indented Blind-corrugated (see p. 560).

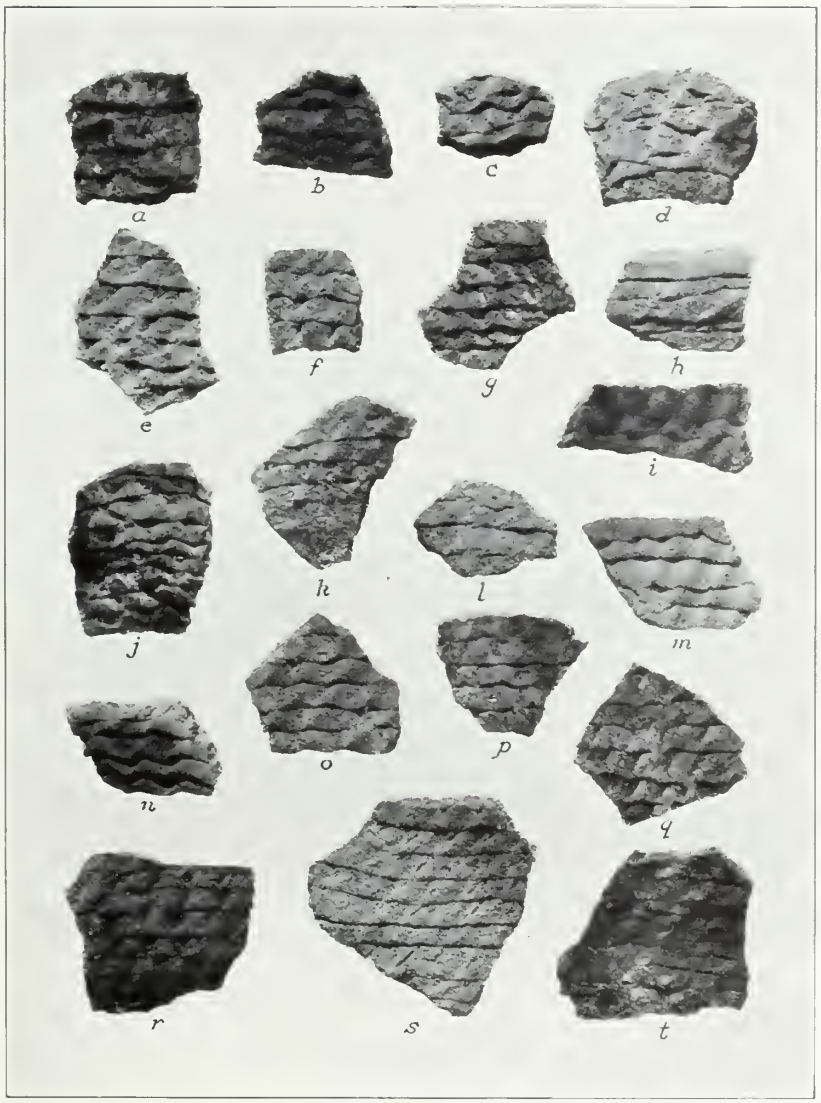


Fig. 255. Culinary ware. Typical Indented Corrugated sherds from Forked Lightning. Note clearly-marked junction lines between the corrugations. (Width of *s*, 2⅜ inches)

PLAIN-SURFACED

A considerable proportion of the culinary sherds from Forked Lightning exhibit either no trace of corrugation, or remain so slight that they can only be discerned when a fairly large piece is held in such a way that the light falls across it at a very low angle. The surfaces vary considerably, some being decidedly rough, others fairly even. But never are they really smooth. How they were finished, I cannot guess; they exhibit few or no tool marks.[1]

USE OF THE TECHNIQUES

The culinary sherds from Forked Lightning, though abundant, are for the most part so small, and we recovered so few whole vessels, that it is difficult to be certain as to just how corrugating, blind-corrugating, and plain finishing were employed. Corrugating and blind-corrugating were apparently never mixed, for no sherd bears more than one of the two. Nor do there appear the alternations of indented with unindented coils, or with plain areas, which are common in other areas. Whatever technique was used seems normally to have been started at the very bottom and to have been carried uninterruptedly to the rim. That there were exceptions to this rule is evidenced by a small number of sherds which show that the lower part of a jar was sometimes plain, corrugation or blind-corrugation beginning at about the point of greatest diameter (fig. 256, *g*). But this was surely uncommon, the greater number of the plain sherds evidently having come from vessels which were plain throughout.[2]

CHRONOLOGICAL ASPECTS OF THE TECHNIQUES

Plain-surfaced cooking ware occurred at all levels of the Forked Lightning ruin, but most commonly in the lower levels (see Graph X, p. 559).[3] Corrugated ware is without question older than Blind-corrugated, for few certainly identifiable examples of the latter are found in the three lowest cuts (5, 6, 7) of Test D (three lowest rows in fig. 254); it occurs in about the same percentage in Cut 4; and it only appears in respectable amounts in Cut 3 (second row from top, fig. 254). In Cuts 1 and 2, however, it preponderates (upper row, fig. 254). These data seem to indicate that Blind-corrugated definitely succeeded Corrugated at about the middle of the Forked Lightning ruin's occupancy.

VESSEL SHAPES

JARS

Although an overwhelming preponderance of the sherds evidently came from large cooking vessels, we have only five specimens sufficiently complete for restora-

[1] See Miss Shepard's remarks on this ware (p. 562).

[2] Miss Shepard's technological study indicates that Plain-surfaced culinary vessels were usually made, in early times at least, of untempered paste different from that used for Corrugated (see p. 562.)

[3] For figures upon the relative abundance of plain and corrugated culinary in the Forked Lightning tests, see graphs and tables in Vol. I (pp. 28-36); in the compilation of these statistics no distinction was made between Corrugated and Blind-corrugated.

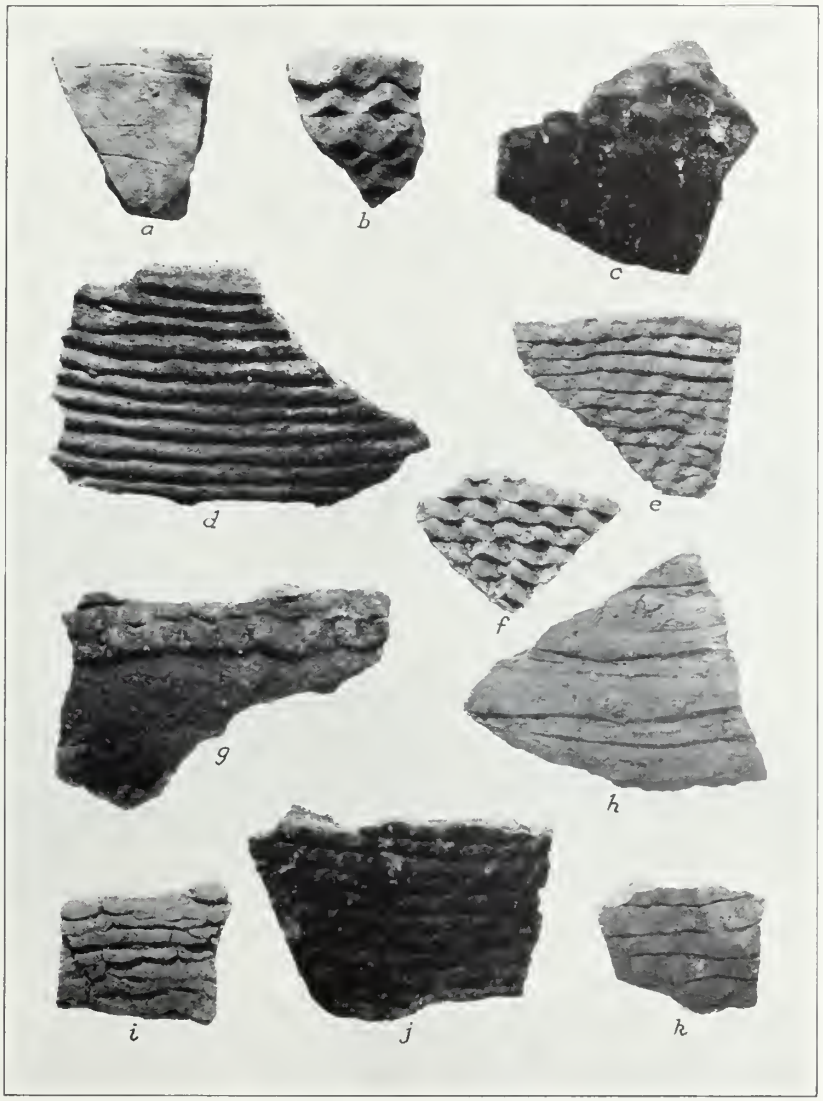


Fig. 256. Culinary ware. Unusual sherds from Forked Lightning. *a:* Nearly obliterated coil-junctions, no indenting. *b, c, f:* Deeply waved corrugation. *d:* Clapboard coil. *e:* Variation in depth of indentations. *g:* Sherd partly corrugated, partly plain. *h:* Roughly scraped surface. *i:* Insufficient plasticity of clay has caused vertical cracks. *j:* Indenting more regular than usual. *k:* Flat coils, very light indentation. (Width of *d*, 4 inches)

tion; all are too fragmentary to permit measurement of capacity. These, as the outline drawings (fig. 257) and photographs (fig. 271, *a*, *b*) show, vary considerably in size and in proportions.

Measurements. In height, the jars run from a little over 10 to just below 13 inches; the diameters are from nearly 11 to nearly 15 inches. Only one (fig. 257, *b*) is taller than it is wide, The orifice is relatively large—from 62 to 75% of the greatest diameter. The base is very gently rounded; in one case (*b*,) it is actually flat; the lower body full. The point of greatest diameter lies at about one-third of the height. There is, however, no distinct shoulder. The upper body is straighter, and therefore

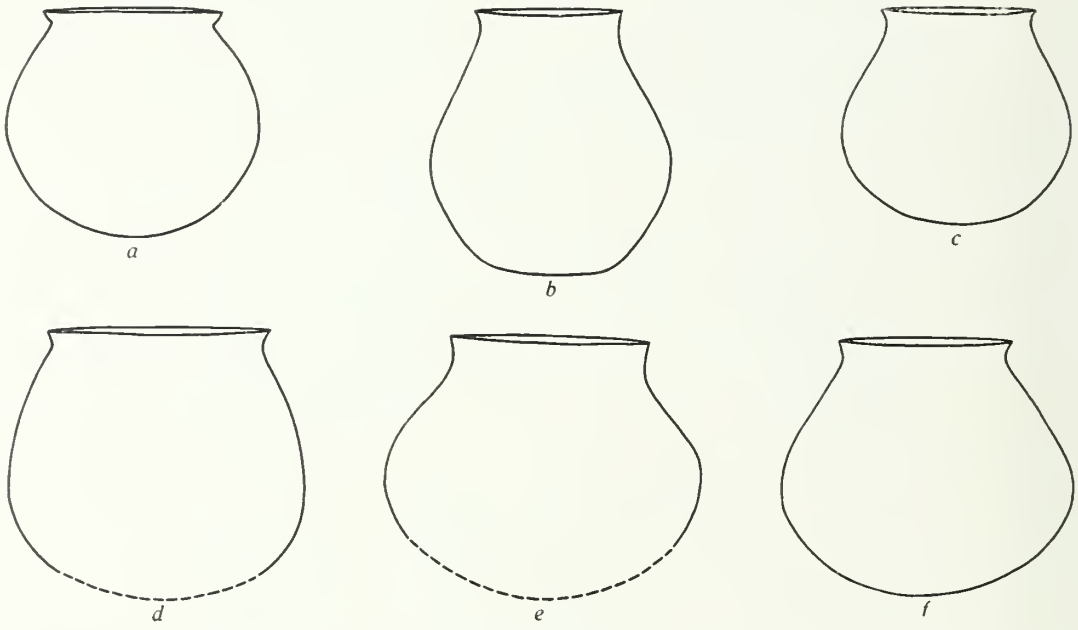


Fig. 257. Culinary ware. Early cooking pots. *a-e:* Forked Lightning. *f:* Dick's Ruin. (1/9)

less full, than the lower. In general, the outline of the vessel resembles that of an egg with the small end cut off. There is no true neck, the upper wall simply curving more or less gently outward at the orifice to form a rim. *Rim* shape can be studied with more thoroughness than vessel form, as there are great numbers of sherds. These show that there is seldom a sharp break between the upper wall and the flaring rim (fig. 266, *a-g*). It is therefore not possible to obtain accurate measurements; but one may say that, on the average, the terminal inch of the wall is involved. There is no thickening. The lip is rounded. The exterior of the rim of any given vessel is in the same technique as its body. The rims of plain vessels are plain. Corrugated vessels have corrugations running to the lip, the terminal coil being somewhat broader than those below because it is not overlapped, as is each lower one, by a succeeding coil.

Where present, blind-corrugation also runs to the lip, but tends to be fainter than on the body.

The interior of all Forked Lightning culinary jars is well finished, more smoothly, in most cases, than the exterior of even the plain-surfaced specimens. But there is never an approach to polish. The work was presumably not done with a rubbing stone, as fine, usually horizontal, striations can be made out on many sherds; Miss Shepard believes them to be the result of finger-finishing. She states that she has been able to reproduce this type of surface exactly by use of the fingers alone.

Fig. 258. Culinary ware. Small vessels from Forked Lightning. Greatest diameter of *d*, 4½ inches)

The interior bottoms of two of our more or less complete jars, and a number of sherds from the same part of broken vessels, show a disintegrative crumbling and pitting, in some cases so severe as nearly to have penetrated the base. Miss Shepard considers that this is probably due to spalling caused by sudden changes in temperature, as when a pot boiled dry, or when liquid was poured into a hot vessel. The area of greatest strain in such cases would, she points out, be on the inner surface between the contents and the heated outer wall of the vessel.

SMALL JARS

Cooking pots of lesser capacity than those described above were evidently made in considerable quantities. Eight specimens came to light in rooms and graves. They are somewhat squattier than the large jars, but resemble them in having the

point of greatest diameter set rather low (fig. 258, *d-g*). Six are Indented Blind-corrugated, one is Indented Corrugated, one Plain-surfaced.

Measurements. The height of the smallest is 4½ inches; diameter, 5 inches; orifice, 3¼ inches; *capacity*, a trifle less than one-half a dry quart (.5 litres). The largest is 7½ inches high, 8 inches in greatest diameter, 5¼ inches across the mouth; its *capacity* is 3 dry quarts (3.3 litres).

DUCK-POT

This form, which was evidently not rare at Pecos, is represented by but one specimen from Forked Lightning (fig. 258, *c*). Duckpots are so called because in shape they faintly suggest a duck's body; and because some of them bear little protuberances, which seem to be conventional representations of wings and tail. Their occurrence in the Pueblo region and the problem of their use will be discussed in the section upon the examples from Pecos. The present very small duck-pot is unique in possessing a little handle on the "breast."

BOWLS

Several fragments and two partly restorable bowls came to light. Although they are made of the same dark, heavily tempered clay that went into the cooking jars, and although they are shaped exactly like the lower parts of such jars, they were not, as I supposed upon first examining them, made by cutting down fired jars whose tops had been broken, for their rims were obviously finished while the clay was still soft. These containers seem to have been improvised from jars whose upper bodies developed some irreparable fault during the moulding process, or, perhaps more probably, while sun-drying. They appear to have been cut off below the point of greatest diameter, to have had their rims smoothed with moistened fingers, and then to have been fired. One of the two restorable pieces and most of the sherds have more carefully finished interiors than are ever possessed by cooking jars of so early a period. There are among the sherds examples of Indented Corrugated, Indented Blind-corrugated and Plain-surfaced wares.

OTHER FORMS

There is a little *pitcher-like vessel* 3¼ inches high (fig. 258, *a*) with a handle of three strips of clay welded together, which runs from the rim to the upper body; and a little *handleless cup* 4¼ inches high (fig. 258, *b*). Handles broken from culinary vessels are even rarer at Forked Lightning than at Pecos.

CULINARY WARES OF PECOS

We have seen that changes in the cooking pottery took place during the occupancy of the village at Forked Lightning, where Indented Corrugated was, toward the end, supplanted by Indented Blind-corrugated. This degenerative, or perhaps one should say simplificational, change continued at Pecos, which town, as Mr. Amsden's studies of Black-on-white have shown, was founded when Forked Light-

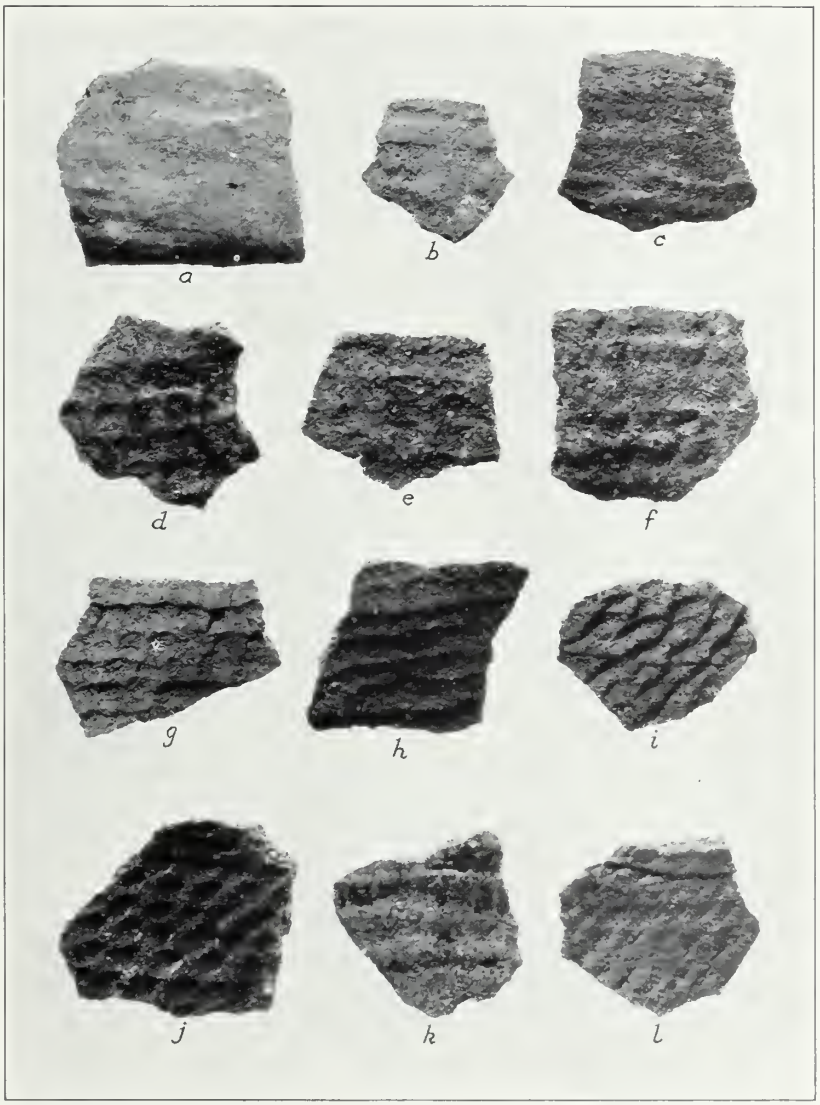


Fig. 259. Culinary ware. Selection of sherds from Test XX to show variation in given horizons and gradual change from strong to faint blind-corrugation. Specimens in the lowest row emanate from Cut 8, a pure Black-on-white deposit; second row from Cut 7, in which Glaze I first appears; third and top rows, Cuts 6 and 5, full Glaze I. (Width of *a*, 2½ inches)

ning was abandoned, the two sites thus representing an uninterrupted sequence of occupation.[1]

The culinary wares of Pecos support Mr. Amsden's conclusions, for the material from the earliest strata of that ruin is indistinguishable from the latest Forked Lightning specimens. It consists of relatively strongly indented Blind-corrugated with a small percentage of Plain. In somewhat later strata the indentations become weaker and weaker; eventually disappearing altogether. Still later wares have almost featureless surfaces. Then faint striation appears, growing progressively stronger in the uppermost deposits.

So culinary pottery, no less than decorated, underwent, during the long life of Pecos, a series of modifications. But these were naturally less striking than those of the painted wares. Their history is also much harder to work out: first, because the changes are subtle; second, because our material is inadequate. Sherds, it is true, were almost unbelievably abundant. But the cooking vessels were so fragile that they broke into very small pieces, which were further crushed by the pressure of the earth in the rubbish heaps. Hence observation is largely restricted to surface treatment; and one must be content with a rather sketchy knowledge of rim form and with extremely poor information regarding vessel shape, both of which criteria, could they have been used to supplement surface treatment, would doubtless have permitted the detailed classification which is a pre-requisite for interpretation of stratigraphic findings and for satisfactory chronological correlation with the decorated wares. For this reason it seems best to present a sort of running commentary upon such material as we have, considering surface texture, upon which our data are most satisfactory, first; then taking up rim form; and, finally, presenting such few observations upon vessel shapes as our scanty collections allow us to make.

SURFACE TREATMENT

On the basis of surface treatment, which, as has been said, is the most abundantly represented, though perhaps not the most significant, criterion for their classification, the Pecos cooking jars can be divided into two major sequent groups. Indented Blind-corrugated, and Striated.

INDENTED BLIND-CORRUGATED

The majority of the earliest Pecos jars were Blind-corrugated. Judging from the body sherds, the vessels were very similar to late examples from Forked Lightning. The indentations are in many cases well marked (fig. 259, *i*, *j*); but, and this was proved conclusively by the stratigraphic tests, they become gradually less and less sharp; they fade, so to speak, away until finally they become undulations so faint as only to be perceptible when the light falls across the surface at a very low angle. Eventually the indentations disappear altogether, and the only evidence of coiling is a barely perceptible horizontal ridging of the surface (fig. 259, *a*). This slow dying out of the indentations Mrs. Kidder and I attempted to express, in a former

[1] Vol. I, pp. 34, 43.

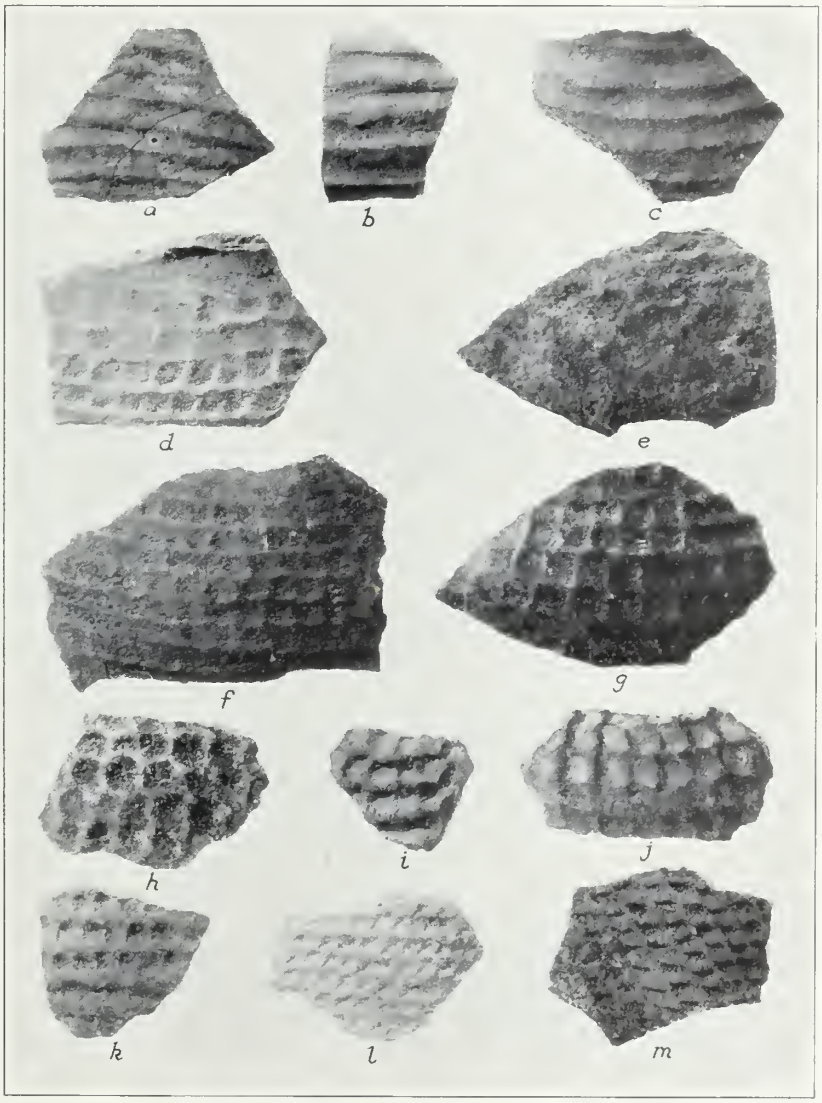


Fig. 260. Culinary ware. Unusual varieties of Blind-corrugated. *a-c:* Unindented Blind-corrugated. *d-k:* Indented Blind-corrugated with "thumb-tip" indentations—this rare variety is associated with Glazes II-IV. *l, m:* Indented Blind-corrugated of the Black-on-white period. (Width of *f*, 5 inches)

paper, by the terms *Strong*, *Medium*, and *Faint Blind-corrugated*[1], which are useful designations if it be remembered that they merely express relative qualities, and that they represent a trend rather than a series of definitely isolable stages. This they are not; but when one lays out, cut by cut, the cook-pot sherds from the lower part of a test, and considers them *en masse*, one can see very clearly a progressive change which is not evident when individual lots are under examination. This is brought out in the series of sherds illustrated in figure 259.

Even in the most strongly marked specimens, whose indentations are clear and sharp, one can almost never perceive any trace of the junctions between the coils. How these lines could so completely have been obliterated without at the same time destroying the indentations, is hard to understand. Possibly a spreading, downward pressure, as distinguished from a more nearly lateral pinch, forced the clay over the junction, thus thoroughly welding the new coil to the one below it.[2] The indentations at any rate, were still made with the thumb, for nail-prints may sometimes be seen. In medium to faint examples the indentations are progressively less distinct. This weakening of the thumb impressions does not seem to have been due to the use of a smoothing tool, but rather to some gradual change in the method of coil manipulation.

The interiors of the blind-corrugated vessels were brought to an even surface, which exhibits no sign whatever of the structural coils. Marks of a tool, in the form of fine, usually horizontal, scratches, are sometimes plainly to be perceived; more often, however, the scratches are so minute that they can only be made out by the use of a hand lens and in a strong, low cross-light. In addition to the scratches, the surface is roughened by innumerable tiny excrescences which produce a definitely rough, gritty feel that is highly characteristic of the early cooking ware. This is due in Miss Shepard's opinion to finger-smoothing of a coarsely tempered paste. The edge of a tool used on a surface containing coarse inclusions, tends to drag protruding particles from the clay and may leave striations as it carries them along; a convex surface, as a stone or a smoothing tool of gourd or sherd tends to imbed particles in the clay leaving a plane, relatively smooth surface; but fingers yield to the unevenness of surface and so coarse inclusions may be covered with a film of clay but not completely leveled with the surface.

Vessel walls are uniformly about $\frac{3}{16}$ of an inch thick; the thinnest piece I have measured is $\frac{5}{32}$, the heaviest, $\frac{1}{4}$ of an inch. The bottoms of vessels are slightly thicker than their walls.

PLAIN-SURFACED WARE

Sherds whose exteriors show no blind-corrugation are not uncommon, even in the earliest deposits.[3] Some of these are evidently from the upper parts of jars which, accordingly, were probably entirely plain; but the majority, it would seem, emanate from the bottoms of jars whose upper bodies were blind-corrugated. There is, indeed,

[1] Kidder, M. A. and A. V., 1917.

[2] Miss Shepard thinks it probable that the junction-line was obliterated before the indentations were produced (see her remarks pp. 560).

[3] See graphs for Texts XIX-XXI, Vol. I, pp. 38-41.

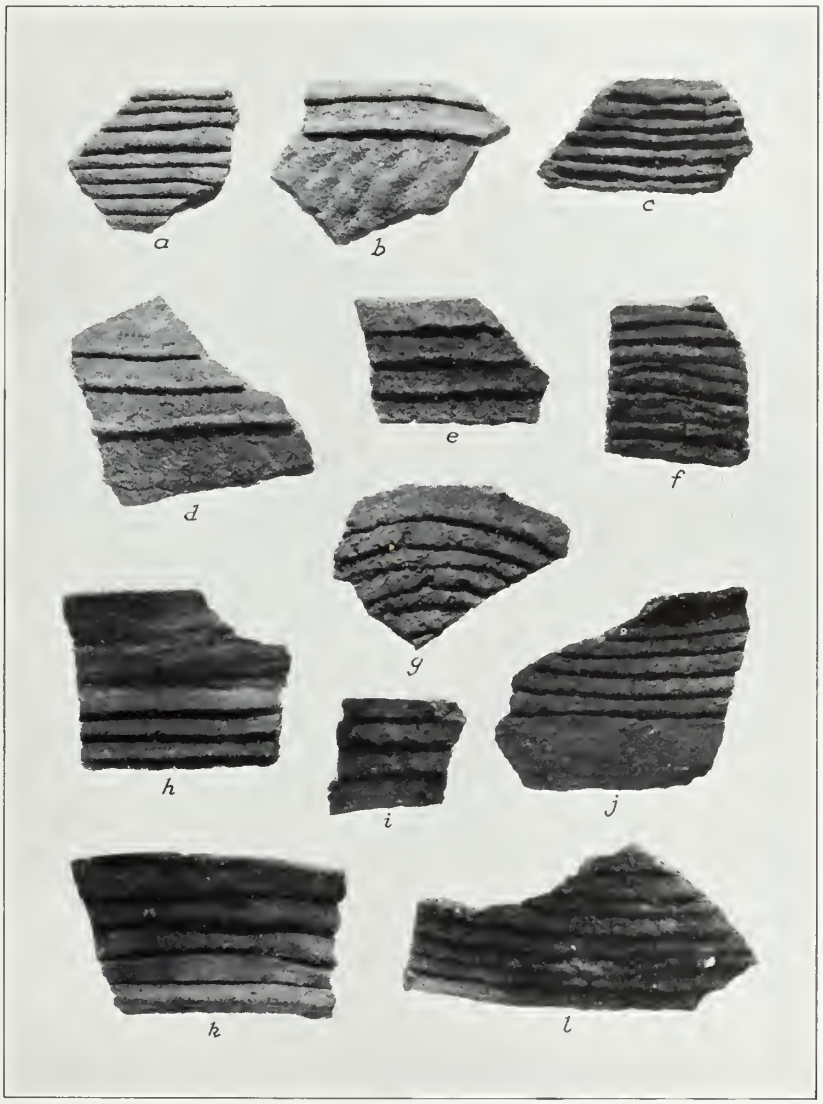


Fig. 261. Culinary ware. Clapboard Corrugated. Sherd *b* shows this type of corrugation combined with indented blind-corrugation. *g:* Sherd from near base of vessel. *h*, *k:* Rim sherds. (Width of *l*, 3 7/8 inches)

reason to believe that the practice of corrugating the bottom, in other words the use of a convex mould for starting vessels, began to fall into disuse soon after the move from Forked Lightning to Pecos. And it is certain that as blind-corrugation became weaker and weaker, a larger and larger proportion of the vessel's base was smoothed. At first the uncorrugated area was restricted to that part which presumably was built in the mould. Then the corrugations were removed from more and more of the lower wall; at last almost no sign of the coils was permitted to remain below the point of greatest diameter.

Before blind-corrugation entirely disappeared there seems to have been a change in the manner of pinching the coil, the ball of the thumb, instead of its side, apparently having been used to apply the pressure necessary for welding. This resulted in wide, shallow indentations, which give the surface a texture not unlike that of hammered brass (fig. 260, *d-k*). The walls of vessels of this class are, as a rule, thin; few pieces measure more than $^3/_{16}$ of an inch and the average is a trifle below that figure.

CLAPBOARD CORRUGATED[1]

Of this rare corrugated pottery (fig. 261) only about sixty sherds were found during the whole excavation. That it was contemporaneous with early Indented Blind-corrugated is proved by its occurrence in the lowest level (Cut 11) of Test XX and by several sherds which, like the one illustrated in fig. 261, *b* are partly Clapboard Corrugated, partly Indented Blind-corrugated. The type seems not to have persisted long, for all the specimens have the gritty feel so characteristic of the oldest Pecos cooking ware.

The overlapping, unindented corrugations are similar to those already described from Forked Lightning (p. 304). Whether or not they ever covered an entire vessel is not certain, although there is one sherd, evidently from near a jar bottom (fig. 261, *g*), which would indicate that they sometimes did. A relatively common practice, however, was to alternate bands of clapboard coils with zones from which the coils were obliterated (*j*). In some cases the corrugations covered the exterior of the rim (*k*); in about an equal number they ended at the base of a smoothed rim (*h*). In width, the corrugations vary from two and one-half to five to the inch. They are boldly overlaping and their lower edges are only rarely squeezed outward by pressure (*d*, *e*); nor were the edges ever removed by scraping.

STRIATED

The finishing technique which produced the striations characteristic of this type came into use just about the time when blind-corrugation disappeared. The faintest and most lightly indented specimens of Blind-corrugated, those with almost smooth surfaces, often bear faint and light scratches, produced presumably by the finger smoothing which had been long in use for finishing the interiors of jars,

[1] In *Notes on the Pottery of Pecos* Mrs. Kidder and I erred in mistaking this actually contemporaneous variant, which we called "Plain Corrugated," for a type transitional between Indented Corrugated and Indented Blind-corrugated (1917, p. 337).

Fig. 262. Culinary ware. Sherds of the Faint-striated type associated with Glaze V. (Width of *a*, $3\frac{5}{8}$ inches)

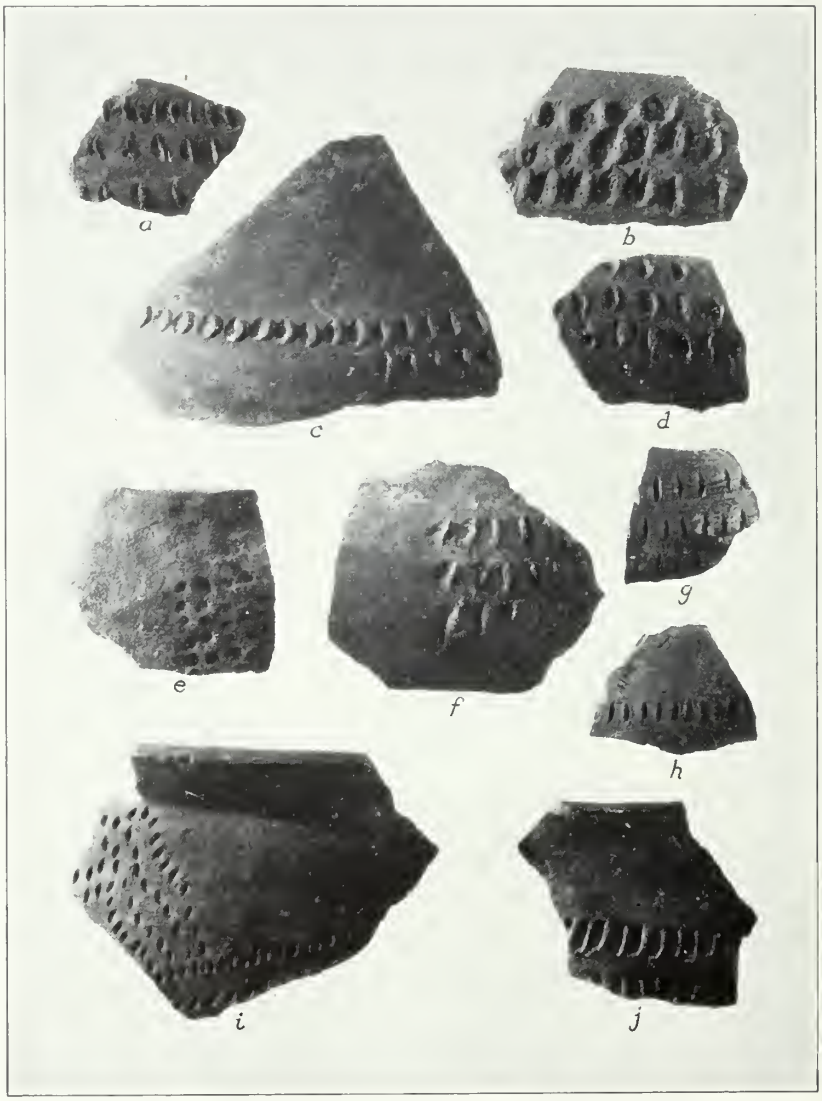


Fig. 263. Culinary ware. Nail-marked (*a-d*, *f-h*, *j*) and Tool-marked (*e*, *i*) types. (Width of *e*, $4^{3}/_{8}$ inches)

for the marks are very similar to those upon the inside of earlier pottery.[1] Such marks are not invariably present; some sherds show that they did not always cover the whole vessel; often they are filled up and hidden by soot. Hence many fragments transitional between Blind-corrugated and Striated are so nearly featureless that Mrs. Kidder and I were led to interpolate, between faint Blind-corrugated and Striated, a type called "Featureless Black"[2], which more careful study makes it now seem useless to retain. Its suppression, however, necessitates distinguishing an early, faintly striated type from a later, more heavily striated one, because other changes, as will be seen, accompanied the accentuation of the marks.

Faint-striated. Stratigraphically superposed on the gritty blind-corrugated pottery is a ware whose exterior surfaces are normally even, although scrutiny of an occasional piece discloses the mere ghost of rippling. I call these surfaces "even" rather than "smooth" because while they are noticeably less rough than even the plain parts of Blind-corrugated jars, they are no no means "slick." What sort of implement was used to finish the exteriors of these vessels is problematical. It left, however, very characteristic light scratches, whose general direction is horizontal, but which angle and criss-cross over each other in a more or less haphazard way (fig. 262).

The interiors of the Faint-striated sherds show a much finer finish than do their exteriors. All the grittiness of the earlier interiors has been eliminated by careful application of the rubbing stone, which has removed almost, but generally not quite, all traces of the scraping tool used for the obliteration of the coils. These surfaces are truly smooth, sometimes really glossy; they just miss being polished. They have a very pleasant "feel", there is not the slight harshness possessed by the exteriors of the vessels, or any of the grittiness of the interiors of earlier jars. Such qualities are not easy to express in words, but to one who has handled many sherds they become strikingly apparent.

The ware is intensely black, the darkest of all Pecos cooking pottery. It seems also to have been less fragile than the earlier products, for the sherds are larger. The interiors of pieces from the bottoms of jars are less deeply and more evenly pitted by whatever agency so severely eroded many Blind-corrugated specimens.[3] In thickness the sherds run from 1/8 to 1/4 of an inch, with 3/16, as before, the commonest thickness; the 3/16 of an inch standard is, however, less closely adhered to, for there are many very thin (1/8 to 5/32) and many heavy (7/32 to 1/4) examples.

Nail-marked (figs. 263; 277, *f*). This is a rare sub-species, so to speak, of Faint-striated ware. It is characterized by series of gouges made with the thumb-nail, which ploughed into the clay, pushing it up into a sharp ridge at the right-hand side of the hollow. This was done after the surface of the vessel had been finished in the usual way, but while it was still soft. Only rather small jars seem to have been decorated in this manner. The marks were applied to the body above the point of greatest diameter and below the spring of the gently curving rim. They sometimes encircled the jar in two or three closely-set horizontal rows (fig. 263, *a*, *b*); sometimes

[1] Miss Shepard feels certain, as result of her experiments, that these striations are due to finger-finishing.

[2] M. A. and A. V. Kidder, 1917, p. 339.

[3] See p. 309.

they were arranged in rectangular blocks, each block containing three sets of marks (*f*). In no case do they appear to have covered any considerable part of the surface.

Tool-marked. Made with some blunt-ended tool, rather than with the thumb-nail, but also used to decorate small Faint-striated jars, are sets of impressed marks (figs. 263, *e*, *i*; 277, *g*). Their arrangement is in rows or blocks; in one instance a band, with incised framing and paneling lines (fig. 277, *g*). Specimens so treated are even scarcer than those with thumb-nail gouges.

Heavily-striated (fig. 264). "Light" and "heavy" are of course relative terms, and they therefore fail to distinguish, with any degree of exactitude, between the wares to which they are applied. By their very vagueness, however, they express what actually took place; for in the same way that blind-corrugation slowly faded out, so did striation of the surface slowly increase. An occasional sherd from an early deposit may be rather deeply striated; late ones are sometimes quite unscratched. But series from the successive cuts of a stratigraphic test clearly show a steady rise in the strength of the scoring.

The surface of this last of the Pecos cooking wares was very roughly treated. The finishing tool was worked back and forth with bold strokes, somethimes actually gouging the clay (fig. 264, *d*), more often leaving sharp striations or scratches, which, on the upper parts of vessels are more or less horizontal, but which, toward the bottom, often run obliquely, or even vertically.

The interiors of Heavily-striated sherds are quite as well, perhaps on the average even better, finished than those of the Faint-striated sort. The rubbing stone was habitually used, occasionally producing almost a true polish.

In color, the ware is seldom a dense black. Many pieces tend to be brownish, some are reddish-brown, others gray. Vessel walls are uniformly ¼ of an inch thick; such few deviations from this standard as occur are toward greater thickness.

RIM FORM

All cooking jars were provided with a more or less flaring rim, which, in contour, underwent a slow but constant modification from early to late times. The rim, however, was, in detail, a variable feature, and the successive chronological styles merge almost imperceptibly into each other. This renders next to impossible any usable classification. I accordingly present the material in, so to speak, narrative form.

Figure 265 illustrates the sequence of rim contours. The earliest cooking jars from Forked Lightning, the Indented Corrugated, have rims which curve gently outward, with no distinct break in contour between vessel wall and rim; they terminate in a rounded lip (*a*). There is not a great deal of variation (see fig. 266, *a-d*).

As indented corrugation was replaced by indented blind-corrugation, the bodies of the vessels tended to become slightly more globular. Although this served somewhat to accentuate the break between body and rim, no real angle was formed (figs. 265, *b*; 266, *e-g*). The above-described rims were contemporaneous with early and late Black-on-white decorated pottery respectively.

The later Blind-corrugated jars had still fuller upper bodies, hence the angle between body and rim became more distinct. At the same time the rim itself became much straighter. At first it was low (fig. 265, *c*), about 1 inch from the angle to the

Fig. 264. Culinary ware. Sherds of the Heavily-striated type associated with Modern painted ware. (Width of *b*, 4½ inches)

still rounded lip; later it grew taller and more nearly vertical (fig. 265, *d*; see also fig. 266, *f-k*). These changes took place between the end of Black-on-white times and somewhere in late Glaze I or Glaze II.

Blind-corrugated jars with thumb-ball, "hammered brass" surfaces (fig. 260, *d-j*) were provided with 1½-to 2-inch rims, at first very straight and nearly vertical (figs. 265, *d*; 267, *a-c*), later tending to curve outward and to lose the sharp angle at the junction with the body (figs. 265, *e, f*; 267, *f-j*). The rather flat lip of many of these specimens is a trifle thickened on the outer edge by clay displaced outward and downward in the process of finishing the orifice (figs. 265, *e, f*; 267, *g-j*). These rims are characteristic of the Glaze III and IV periods, the straight examples having ap-

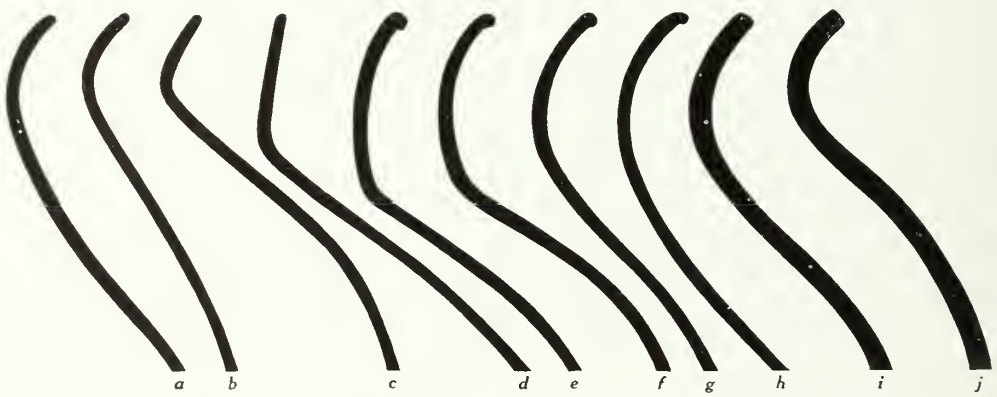


Fig. 265. Culinary ware. Rim profiles of large jars illustrating the general trend of the changes which took place during Pueblo occupancy of the Pecos Valley. Approximate correlations with surface textures are: *a*, with Indented Corrugated (Forked Lightning); *b*, with Strongly Indented Blind-corrugated (Forked Lightning and early Pecos); *c*, *d*: with Strongly Indented to Medium Indented Blind-corrugated; *e*, *f*, with Faintly Indented Blind-corrugated; *g*, *h*, with Faint-striated; *i*, *j*, with Heavily-striated. Approximate correlations with wares: *a*, *b*, with Black-on-white; *b*, *c*, with Glazes I, II; *c*, *d*, with Glazes II, III; *d*, *e*, *f*, with Glazes III, IV; *g*, *h*, with Glaze V; *i*, *j*, with late Glaze V, Glaze VI, and Modern. (1/2)

parently been roughly contemporaneous with Glaze III, the more curved ones with Glaze IV.

At about the time when corrugation disappeared and faintly striated surfaces came in, the rim once more took on sweeping lines and the angle with the body completely disappeared (figs. 265, *g*, *h*; 268, *a-e*). Examples from this period are beautifully curved and remarkably uniform, so uniform, indeed, that in the field we used to notice how easily large numbers of sherds could be nested together for packing. The smoothing of the interior, which is characteristic of these jars, runs up to, and sometimes over, the lip, which is again more rounded but which often still has the little exterior overlap of clay forced downward in the finishing process. The correlation is definitely with full Glaze V. This, indeed, is the only rim form that is restricted to a single Glaze period.

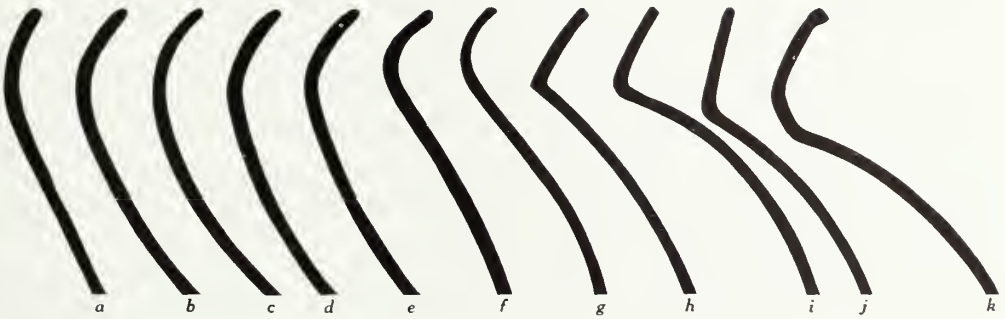


Fig. 266. Culinary ware. Rim profiles of large jars. *a-g:* Black-on-white period. *h-k:* Early Glaze period. (1/2)

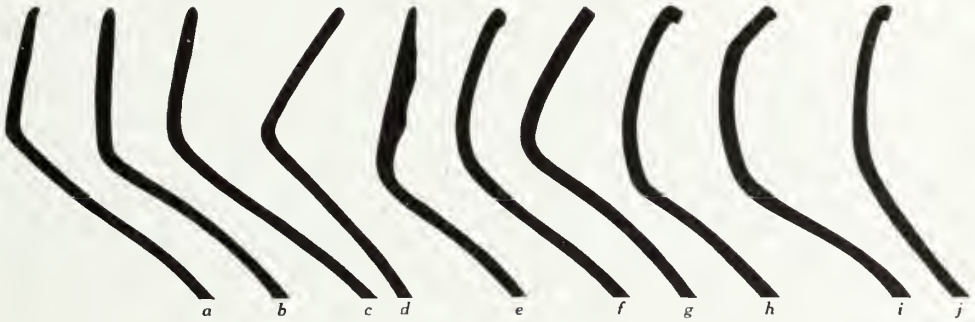


Fig. 267. Culinary ware. Rim profiles of large jars of the Glaze II (?), III, and IV periods. (1/2)

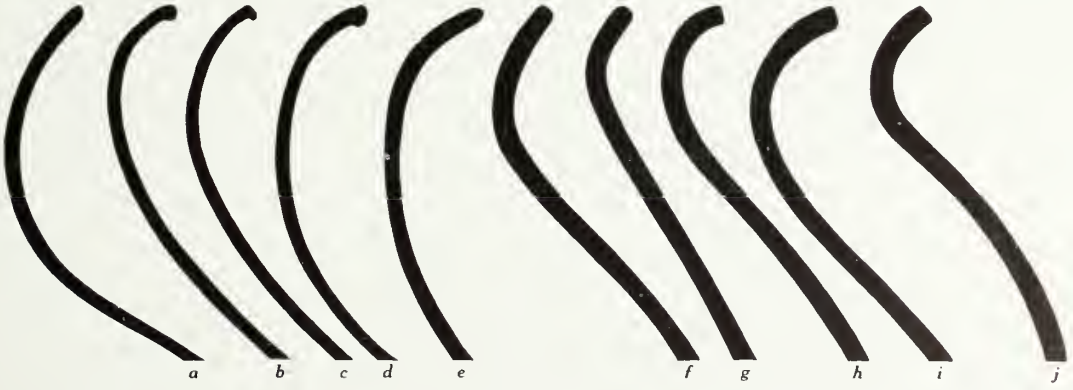


Fig. 268. Culinary ware. Rim profiles of large jars. *a-e:* Glaze V period. *f-j:* Modern period. (1/2)

The latest cooking pottery of Pecos, the Heavily-striated, has a very distinctive rim, curved outward sharply, because the vessel once more becomes globular-bodied (figs. 265, *i*, *j*; 268, *f-j*). There is, however, no trace of an angular "spring". An occasional specimen is somewhat heavier than the vessel wall, but thickening is not characteristic[1]. The lip is squared off, its flat surface inclining outward. Correlation is with late Glaze V, Glaze VI, and Modern. This type of rim thus had a longer life than any other, yet it did not change perceptibly from the canons established when it first came into use.

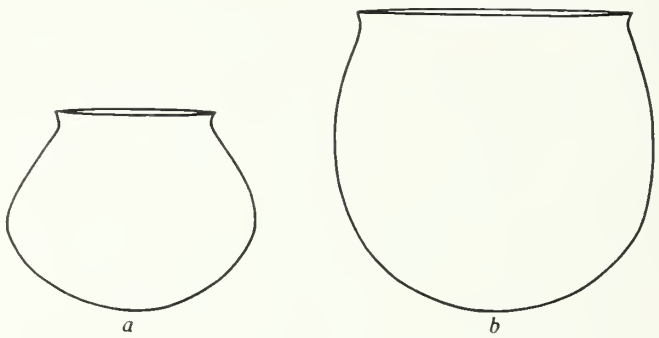


Fig. 269. Culinary ware. Outlines of Indented Blind-corrugated jars of the Black-on-white period. Jar *b* is of exceptionally large size and its orifice is unusually wide. (1/9)

JAR FORM

The large jar was by far the most common cooking utensil at Pecos. Fully 90% of all the culinary sherds emanate from such vessels. We possess, however, so few whole specimens that we have been forced to base our study largely upon surface finish and the contour of the rim, leaving until the last the equally important attribute of vessel shape.

The earliest cooking jars of the Pecos Valley, those from Forked Lightning, were, as we have seen, fairly high in relation to their width; the point of greatest diameter was low; in outline they suggested an egg with the small end removed (fig. 257). The same general form presumably continued for a while to be made at Pecos, for the sherds indicate that there was at first little change in surface texture or in the rim. Furthermore, our one surely identifiable early jar conforms to the Forked Lightning standard, although it is somewhat squattier. This rather lopsided vessel (fig. 269, *a*) was found cached in pure Black-on-white débris. The base is plain. A distinct mould-mark can be seen just below the beginning of the rather strongly indented blind-corrugation which covers the rest of the body to the lip. At the junction between the plain base and the blind-corrugation there is a clean encircling break, which of course implies failure properly to weld the first of the blind-corrugated coils. *Measurements:* orifice, 7½ inches; height, 9¼ inches; greatest diameter, 11⅝ inches. *Height—greatest diameter index*, .79; *orifice—greatest diameter index*, .64; *ori-*

[1] The rim figured in Kidder, M. A. and A.V., 1917, pl. II, 12, is not typical.

fice—height index, .81.[1] *Capacity*, 8½ dry quarts (9.3 litres). It is, of course, unsafe to generalize from a single specimen, but the rather low height—greatest diameter index may be taken to indicate a gradual transition, during Pecos Black-on-white times, between the relatively tall Forked Lightning jars and the very squatty ones characteristic of Glaze I.

The piece just described seems, from the sherds, to have been typical. Another jar, unfortunately very fragmentary, which was also found in a Black-on-white deposit, is of an entirely different sort. The surface is unindented, but the nearly obliterated junction lines of the coils may be made out. Its chief peculiarities are its unusually large size and very broad orifice (fig. 269, *b*). *Measurements:* orifice, 12¾

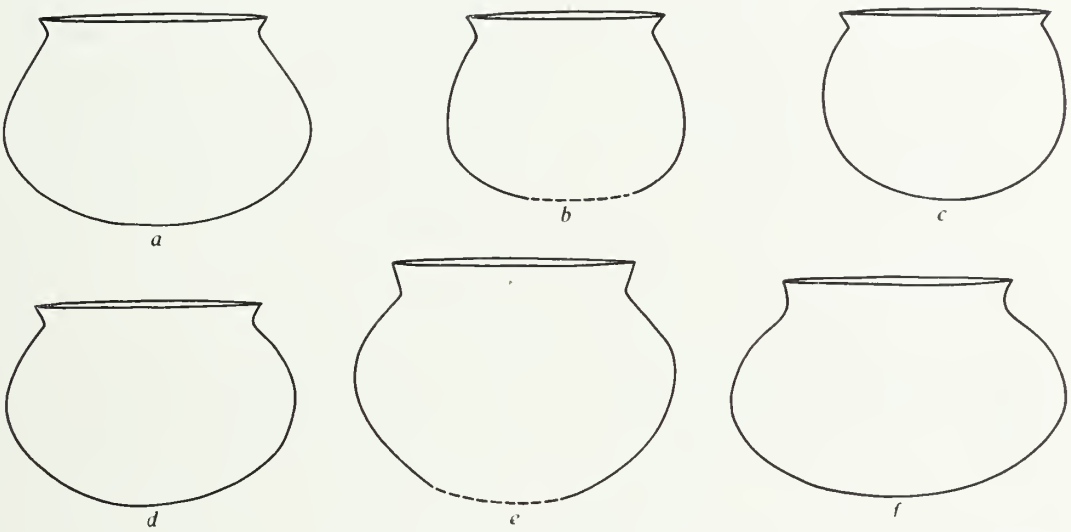


Fig. 270. Culinary ware. Outlines of jars of Faint Blind-corrugated ware. *a:* Glaze I period (for photograph see fig. 271, *c*). *b-d:* Glaze I or II (for photograph of *d* see fig. 271, *d*). *e,f:* Glaze III or IV. (1/9)

inches; greatest diameter, 14⅝ inches; height, 14¼ inches. *Height—greatest diameter index*, .97; *orifice—greatest diameter index*, .87; *orifice—height index*, .89. Approximate *capacity*, 30 dry quarts (33 litres).

The above two specimens are safely assignable to the Black-on-white period. Early Glaze times are represented by four jars, two whole, two fragmentary. One of them (figs. 270, *a*; 271, *c*) is surely to be correlated with Glaze I, as a Glaze I Red bowl came from the same grave; the other three (fig. 270, *b-d*; a photograph of *d* appears at *d* of fig. 271), unfortunately unaccompanied by decorated vessels, are from graves in Glaze I rubbish and, judging by their rims, are probably also of the Glaze I period, certainly not later than Glaze II. The first-mentioned piece has a plain surface, the rest are medium to faint indented blind-corrugated from the point

[1] Formulae: $\frac{\text{ht.} \times 100}{\text{g.d.}}$; $\frac{\text{orif.} \times 100}{\text{g.d.}}$; $\frac{\text{orif.} \times 100}{\text{ht}}$. In other words, the height, in this case, is 79% of the greatest diameter; orifice is 64% of greatest diameter; orifice is 81% of height.

of greatest diameter upward, plain (though showing traces of former, apparently unindented, corrugation) over the whole bottom. All these pieces are well made, symmetrical, and relatively light. Their rims break sharply away from their bodies, the sharpness of the angle being caused by the fullness of the body, which carries the vessel wall quickly outward. This rotundity of body is accompanied by great width of mouth. *Measurements:* orifices, 9½, 10, 10½, 10⅞; greatest diameters, 11¼, 11¼, 13½, 14; heights, 8⅝, 8⅝, 9⅜, 9¾. *Height—greatest diameter indices*, .76, .76, .69, .69. *Orifice—greatest diameter indices*, .84, .88, .77, .77. *Orifice—height indices:* 1.10, 1.15, 1.12, 1.11. *Capacities* (only two measurable), fig. 270, *a*, 13½ dry quarts (14.8 litres); fig. 270, *d*, 12 quarts (13.2 litres).

For study of the jar form of Glaze III and Glaze IV our data are most unsatisfactory. We have one fragmentary specimen which, from sherds in the grave, cannot be earlier than Glaze III. Its broad, straight rim (fig. 270, *e*) corresponds well with rim-fragments from the Glaze III-IV strata in the rubbish heaps. The upper body is blind-corrugated, the indentations very large, but very shallow, as if made with the ball, rather than with the side, of the thumb. The bottom bears faint traces of obliterated coils. As the outline drawing shows, the body is full and squat. *Measurements:* orifice, 10¼; greatest diameter, 15; height, 10¼. *Height—greatest diameter index*, .75. *Orifice—greatest diameter index*, .75. *Orifice—height index*, 1.00. *Capacity* cannot be measured.

A second jar (fig. 271, *f*), whose archaeological position could not be determined, but whose low, full body and broad, though curving, rim seem to place it somewhere in the Glaze III or IV periods, has blind-corrugated surface with rather well-marked thumb-ball indentations. *Measurements:* orifice 10⅞; greatest diameter, 15¾; height, 10⅛. *Height—greatest diameter index*, .64. *Orifice—greatest diameter index*, .69. *Orifice—height index*, 1.06. *Capacity* not determinable, but probably about 13 dry quarts (14.3 litres).

Although the Glaze III-IV period is represented only by the two above-described specimens, the abundant sherds safely attributable to this general stage prove, by the abrupt flare of the rim and the swelling curve of the upper body, that the jar was normally squatty and that it was as fully rounded above as below the point of greatest diameter.

With the opening of the Glaze V period there disappeared, as we have seen, all signs of corrugation; and the exterior surfaces of vessels began to bear the striations of a finishing tool. At the same time the angle between rim and body faded to a long, sweeping curve. It is this curve which gives us practically all the information we have regarding the form of the body of the faintly striated jars, for, most unfortunately, there were collected, of these technologically excellent and evidently beautifully formed vessels, but two reasonably complete examples. The larger of these (fig. 272, *b*) is apparently the more typical. It indicates a return toward the canons of the Black-on-white period in that the upper wall is relatively straight, the point of greatest diameter low, and the vessel high in proportion to its width. It differs from specimens of the Black-on-white period in greater width of orifice. *Measurements:* orifice, 9 inches; height, 9¾; greatest diameter, 11¼. *Height—greatest diameter index*, .83. *Orifice—greatest diameter index*, .80. *Orifice—height index*, .96. *Capacity*, about 8 dry quarts (8.8 litres).

Fig. 271. Culinary ware. *a*, *b:* Indented Corrugated jars of the Black-on-white period from Forked Lightning (note change in nature of indentations between base and upper part of *a*). *c*, *d:* Faint Indented Blind-corrugated jars from Pecos: *c*, Glaze I; *d*, Glaze I or II. (Height of *a*, 12½ inches)

The smaller jar (fig. 272, *c*) has the typical curving rim and large mouth of the period, but it is relatively less tall. *Measurements:* orifice, $8\frac{5}{8}$ inches; height $7\frac{1}{2}$; greatest diameter, $9\frac{3}{4}$. *Height—greatest diameter index*, .76. *Orifice—greatest diameter index*, .88. *Orifice—height index*, 115. *Capacity*, $5\frac{1}{4}$ dry quarts (5.6 litres).

Both the foregoing specimens are evidently smaller than the average, for most of the rim sherds are from jars whose mouths were 10 to $11\frac{1}{2}$ inches across, while there were many of 12 to 13 inches and some as much as 15 and 16 inches from lip to lip. None of the fragments, however, preserves enough of the side to show the full curve of the body; but from the steep pitch of the upper wall, it seems likely that the restorations made in fig. 272, *a* are within the limits of probability for a jar with $12\frac{3}{4}$-inch rim. This piece must have had a *capacity* of between 15 and 20 dry quarts

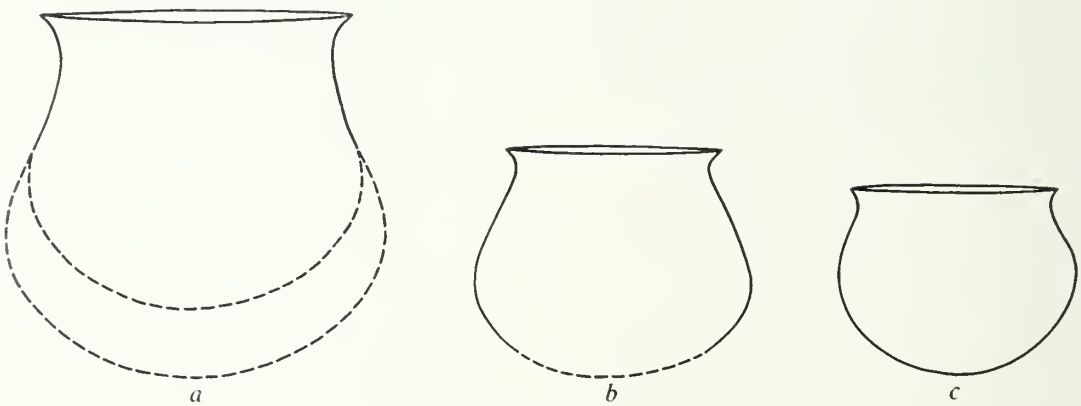


Fig. 272. Culinary ware. Faint-striated jars of the Glaze V period. *a:* Restoration of unusually large specimen; the outline of the lower body probably lay somewhere between the limits shown by dotted lines. *b*, *c:* Jars of smaller than average size. (1/9)

($16\frac{1}{2}$ to 22 litres); the commoner form with 10- to 11-inch mouth should have held from 10 to 15 dry quarts (11 to 16.5 litres).

As to the heavily striated and generally thicker-walled and coarser cook-pots which came into use toward the end of Glaze V and remained steadily in favor until the end of the occupancy of Pecos, we have much fuller information than as to any earlier group. A cache of eight jars dating from terminal Glaze V came to light in the North Quadrangle; several others were found in rooms abandoned presumably during the Modern period; two collapsed chimneys that had been made of superimposed bottomless cooking jars yielded a number of partly restorable pieces; the refuse in chambers that fell into disuse as the population shrank contained many large sherds. Study of the material indicates a marked change in form. It also seems to show that there was greater variety both in shape and in size than obtained in the earlier groups; however, equally large collections from those groups might well prove them to have been less uniform than is indicated by the few whole specimens which we possess.

The change in form just mentioned consists of an increased fullness of the upper body, which does away with the long, graceful sweep toward the rim that was characteristic of the Faint-striated jars (cf. fig. 272); and a raising of the point of greatest diameter. The vessels are accordingly rounder bodied and squattier than their immediate predecessors and closer, in general contour, to those of the late Blind-corrugated group (cf. fig. 270). From the latter, however, they differ in surface finish; they have thicker walls; the rim is low and curls outward without an angular break (cf. figs. 265, *i*, *j*; 268, *f-j*).

In the accompanying table are given *measurements*, *indices*, and *capacities* of the pieces drawn in outline in figure 273 (estimates bracketed). The jars, it will be seen, run from 7½ to 13⅛ inches high; and, in capacity, from 4 to 15½ dry quarts (4.4 to 17 litres). Study of the outline drawings and photographs (figs. 273, 274) and of the indices presented in the table, shows that the smallest and largest vessels are, on the average, relatively tall; whereas the middle-sized pieces are generally squat.

Fig. 273	Cat. no.	Found in:	Dimensions, inches			Indices			Cap'y dry qts.
			Orif.	Height	Gr. diam.	Ht. Gr. d.	Or.-G.d.	Ht. Orif.	
a	69744	Room 30	6 3/8	7 1/2	8 3/4	.85	.71	1.19	4
b	69723	Room 26	6 3/8	(7 7/8)	8 5/8	(.91)	.73	(1.23)	(4)
c	69726	Room 26	6 5/8	(7 7/8)	8 5/8	(.88)	.76	(1.18)	(4)
d	69725	Room 26	7 5/8	(8 5/8)	9 5/8	(.89)	.69	(1.13)	(5)
e	69725	Room 26	7 3/4	(8 1/4)	10 1/8	(.81)	.76	(1.06)	(5 1/2)
f	66920	N. Terr.	8 5/8	7 7/8	11 1/4	.70	.76	.91	5 3/4
g	66933	Room 2	7 1/4	9	10 1/2	.85	.69	1.27	6
h	69723	Room 26	7 1/2	(8 5/8)	10 3/4	(.80)	.70	(1.15)	(6)
j	66934	Room 2	9 3/8	8 5/8	10 7/8	.79	.86	.92	6 1/4
j	66935	Room 2	9 3/8	8 1/4	11 1/4	.73	.83	.88	6 1/2
k	66936	Room 2	9	9 3/8	12	.79	.75	1.04	9
l	69750	Room 32	10 7/8	9	13 1/2	.66	.80	.82	11
m	69724	Room 26	6 3/4	10 7/8	12	.90	.56	1.61	11
n	66932	Room 2	9 3/8	10	13 1/8	.76	.71	1.06	11 1/2
o	66935	Room 2	9 3/4	10 3/8	13 1/8	.82	.74	1.06	12 1/2
p	66931	Room 2	9 3/8	12	13 1/2	.88	.70	1.28	13
q	71111	Gen. Dig.	9 3/4	(12)	15 3/8	(.78)	.63	(1.23)	(15)
r	66937	Room 2	8 1/4	13 1/8	15 3/8	.85	.53	1.59	15 1/2

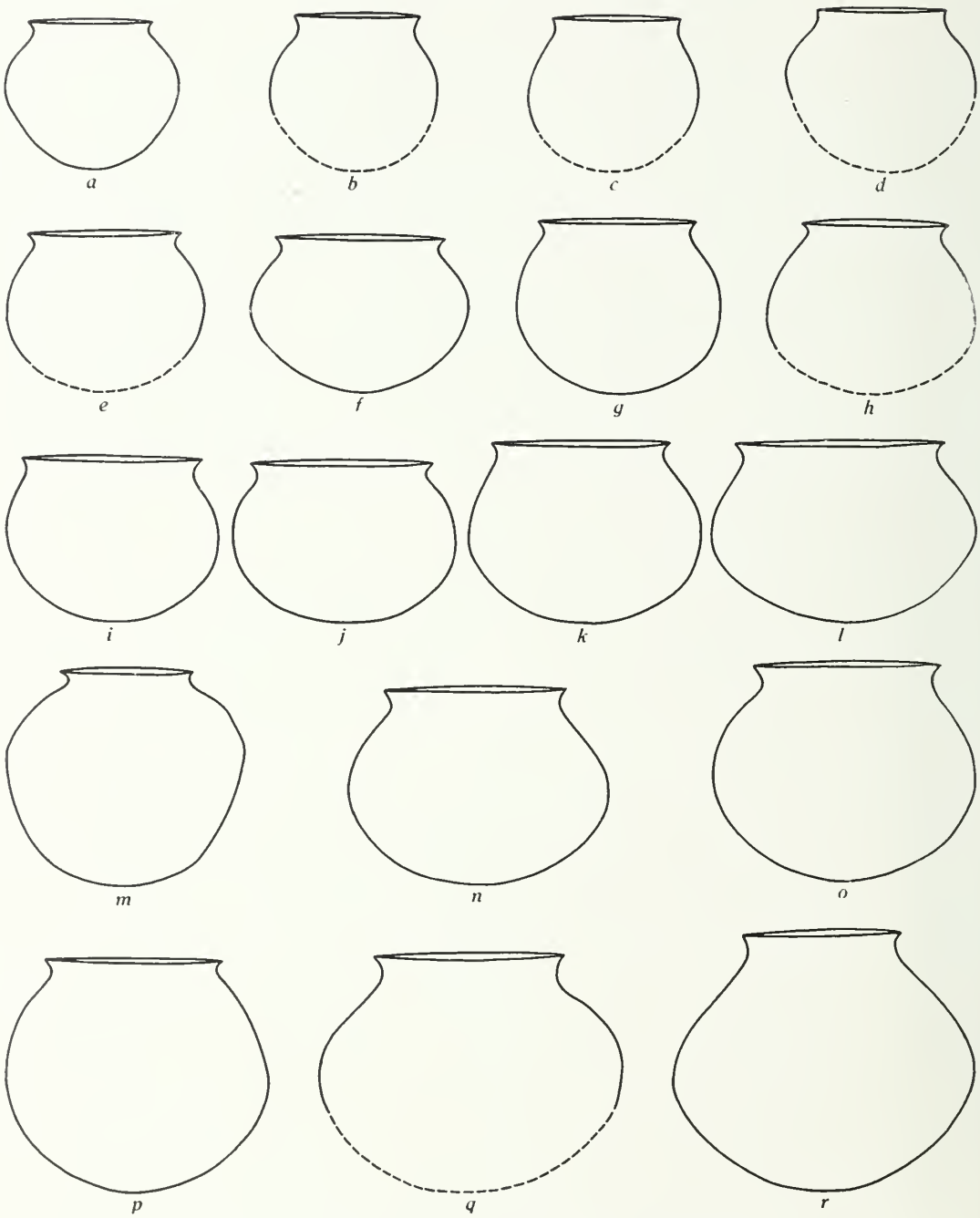


Fig. 273. Culinary ware. Heavily-striated jars of the Modern period. Vessels *b-e*, *h*: and *a*, *c*, *e* of fig. 276 were nested to form two chimneys in Room 26, North Quadrangle. Vessels *f*, *g*, *i*, *j*, *k*, *n*, *o*, *p*, *r* were found together in and near Room 2, North Terrace. For photographs of specimens of this type, see figs. 274; 275, *b-e*. (1/9)

Fig. 274. Culinary ware. Heavily-striated jars of the Modern period. Vessels *b*, *d*, *e*, *f* and *d*, *e*, of fig. 275 formed part of a cache of nine jars buried in late rubbish in Room 2, North Terrace. (Height of *f*, 13¼ inches)

Fig. 275. Culinary ware. Heavily-striated vessels. *a:* Cajete. *b-e:* Jars. (Diam. of *a*, $11\frac{5}{8}$ inches)

In view of the long period during which Heavily-striated jars were made, it is probable that their shape underwent more or less modification. There is evidence, indeed, that the rim tended to become lower and more abruptly flaring (see fig. 268, *j*); but we have not enough whole specimens nor are they sufficiently well dated relative to each other, to permit judgment as to changes in body-form. That there was considerable variation in shape at any given period is suggested by the strong differences which exist among the nine presumably contemporaneous jars found together in Room 2 (fig. 273 *f*, *g*, *i*, *j*, *k*, *n*, *o*, *p*, *r*). The specimen shown at *m* is probably the latest in the collection; it was found in association with a Modern painted olla (illustrated in Vol. I, fig. 87, *c*) in Room 26, a chamber apparently abandoned toward the end of the eighteenth century.[1] Whether or not its rather high-shouldered body is typical of the period, I do not know.

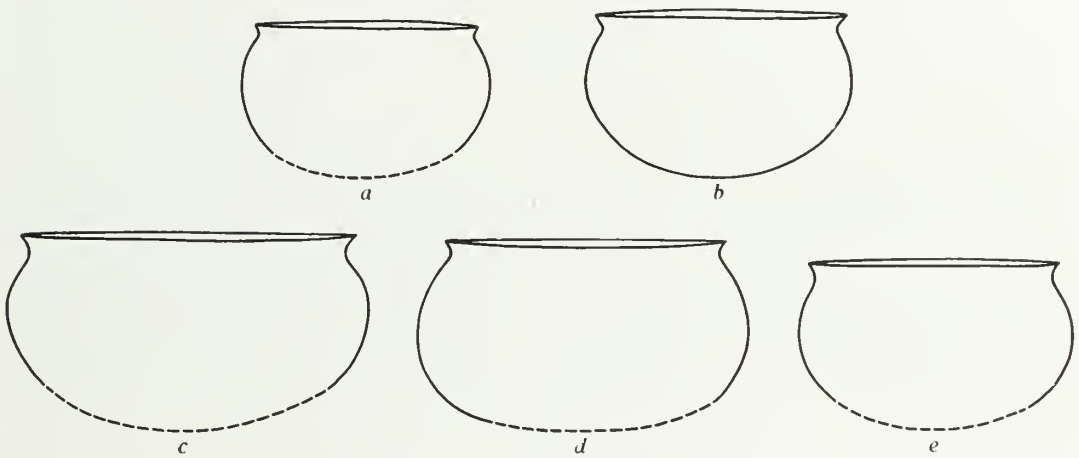


Fig. 276. Culinary ware. Cajetes of Heavily-striated ware. *a*, *c*, *e*: Chimney-pots from Room 26. For photograph of *b*, see fig. 275, *a*. (1/9)

CAJETES

This word, used in New Mexico to designate a large tub-like pottery container, is applied, in order to avoid calling them bowls, to a group of cooking vessels which seem only to have been made during the period of Heavily-striated cooking ware. Three examples, complete save for their bottoms, formed part of one of the above-mentioned chimneys; two came to light in Room S-3 and S-60 respectively; and sherds occurred commonly in all beds of late refuse. As the illustrations (figs. 275, *a*; 276) show, the form is midway between a jar and a bowl. The body is fully rounded, the point of greatest diameter well beyond the lip. The *rim*, like that of the jar, curves sharply outward to terminate in a squarish or rounded lip. The exterior

[1] The chimney was also in this room, but there is of course no way of telling when it was erected. It was doubtless due, however, to Spanish influence, as we have no record of pre-Columbian Pueblo chimneys of this or any other form.

surfaces are indistinguishable from those of jars; the interiors are excellently smoothed, in some cases really polished. *Measurements* and *indices* appear below. Of only one specimen (fig. 276, *b*) can the *capacity* be determined; it holds 8½ dry quarts (9.3+ litres); from the size of the fragmentary examples and from the sherds, it would appear that the average capacity must have been well over 10 dry quarts (11 litres); the largest cajetes (fig. 276, *c*) doubtless held in the neighborhood of 20 dry quarts (22 litres).

Fig. 276	Cat. no.	Found in:	Dimensions, inches			Indices			Cap'y dry qts.
			Orif.	Height	Gr. diam.	Ht.-Gr. d.	Or.-G.d.	Ht.-Orif.	
a	69726	Room 26	10 1/2	(7 1/8)	11 5/8	(.61)	.90	(.69)	(7)
b	72627	Room 60	11 5/8	7 1/2	12 3/8	.60	.94	.64	8 1/2
c	69726	Room 26	15 3/4	(9)	16 7/8	(.56)	.96	(.57)	(20)
d	66938	Room 3	13 1/8	(8 5/8)	15 3/8	(.56)	.85	(.65)	(15)
e	69726	Room 26	11 5/8	(7 7/8)	12 3/4	(.61)	.91	(.67)	(8 3/4)

SMALL JARS

Some twenty-five small vessels were recovered, mostly from the graves of infants and young children. They range in size from 2 or 3 inches to 6½ inches in height; and in capacity up to 4 dry quarts (4.2 litres). Most of them are sooted to about the same degree as the large jars. A selection is presented in fig. 277; the caption records their probable period assignments. It will be noted that the pieces follow more or less closely the canons of shape of the chronological groups to which they belong.

HANDLED JARS

Handles were apparently never attached to the more capacious culinary containers; nor were they often used, as far as could be made out, upon the small jars with faintly or strongly striated surface. But in earlier times there was limited use of handles upon little vessels, which, from the curvature of the sherds, would seem to have been of 1- to 4-quart (1.1 to 4.4 litres) size. Even upon such pieces they were far from common, as the collection contains less than one hundred black handles or fragments thereof and, as we shall see, there were usually two to each vessel.

Study of the material shows that the handles were ordinarily cylindrical or slightly flattened. They were placed, normally vertically, on opposite sides of the vessel close below the rim (figs. 278, *h*; 279, *k-m*). There are a few examples which seem to have been placed horizontally at or near the point of greatest diameter (fig. 279, *g*). There are no long vertical ones which might have come from pitcher-like forms. Both vertical and horizontal handles are generally so small that a finger can-

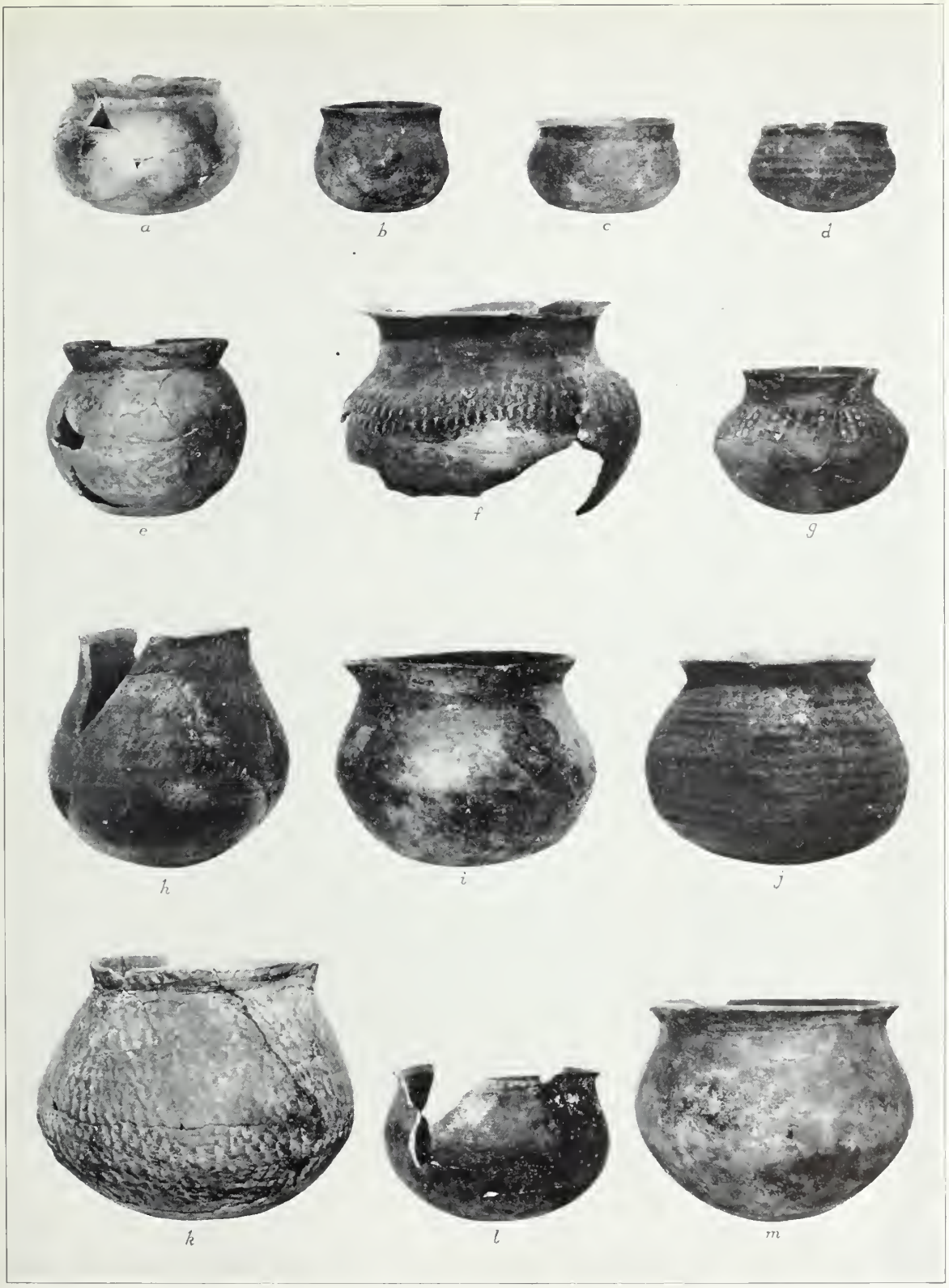


Fig. 277. Culinary ware. Small vessels. *a:* Plain-surfaced, period uncertain. *b:* Plain-surfaced. Glaze III. *c:* Faint Blind-corrugated, Glaze II. *d:* Strong unindented Blind-corrugated, Glaze I. *e:* Rough Plain-surfaced ware, probably 18th Century. *f:* Nail-marked, Glaze V. *g:* Tool-marked, probably Glaze V. *h*, *j*, *k:* Faint Indented Blind-corrugated, Black-on-white. *i:* Plain-surfaced, Glaze V. *l:* Faint-striated, Glaze V. *m:* Heavily-striated, probably 18th Century. (Height of *k*, 6½ inches)

not pass through them. The majority are plain; handles made of twisted or braided strands of clay, or of two or more strands side-by-side, so abundant in certain other regions[1], are absent, the only exceptions being a very few specimens whose outer surface has been pinched into oblique ridges to produce a twisted effect (fig. 229, *a-c*). All handles were evidently fastened to the vessel wall by the riveting method (see p. 263 and fig. 279, *e*).

Fig. 278. Culinary ware. Bowls, duck-pots, and small jars with handles. Period assignments—*a:* Glaze II-III. *b:* Black-on-white (?). *c:* Probably Glaze II. *d:* Glaze IV. *e:* Glaze III-IV. *f:* Probably Black-on-white. *g:* Glaze IV. *h:* Glaze III. *i:* Glaze IV or V. (Height of *h*, 4¾ inches)

[1] The Mimbres, for example, see Cosgrove, 1932, pls. 97-99.

Fig. 279. Culinary ware. Handles and lugs. Specimens *e*, *f* illustrate the "riveting" method of attaching handles. (Height of *k*, 2 1/4 inches)

Of whole or restorable cooking vessels with handles, we recovered but three. The earliest (fig. 278, *h*) is a well-made jar of about 4 dry quarts (4.4 litres) capacity, faintly indented blind-corrugated above the point of greatest diameter, plain-surfaced below. A vertical handle with pinched-up flanges along its outer edges is placed on either side. It was found in a Glaze III horizon. The second piece (fig. 278, *g*) probably dates from Glaze IV. The exterior surface is very faintly indented blind-corrugated throughout. On each side, close below the rim, is a pair of small animal figures. Only one other specimen of this sort (a fragmentary handle—fig. 228, *e*) was found at Pecos. The third handled jar (fig. 278, *i*) is presumably of Glaze V period. Its exterior surface is practically featureless, although the merest trace of coil-rippling may be discerned. The capacity is 1 1/2 dry quarts (1.65 litres). The two handles are, as usual, set upon opposite sides.

DUCK POTS

These peculiar little vessels are characterized by a more or less pointed extension of one side, which gives them a faint resemblance to the body of a rather plump bird. That this was recognized by the potters is shown by the fact that to some of the specimens were added small lumps of clay to represent the tail and the wings. But the result is by no means realistic. Whether or not the duck was actually the bird symbolized is unknown.

Of thirteen specimens, twelve are from graves ranging in period from Black-on-white to Glaze IV[1]. The form appears to have been a fairly common one, for many sherds bearing the typical wing and tail nubbins were found. We have, however, no evidence that it was made after the close of Glaze IV; but that it was absent from the later periods is not certain, as we have practically no mortuary pottery of Glaze V and none at all from the Modern period; while the little nubbins, which alone permit confident identification of duck-pot sherds, seem to have dropped out of use after Glaze I.

The outline drawings (figs. 280, 281) show the great variability of the Pecos duck-pots both in size and in shape, examples running from 4 1/2 to 11 inches long. The earliest specimens (including one from Forked Lightning—fig. 258, *c*) are either faint-indented blind-corrugated or plain. All of them are of the same gritty-feeling ware as the contemporary large cooking jars. Most, but not all (see caption, fig. 280, which lists the period assignments), have a rather heavy "tail" nubbin, a smaller "wing" nubbin on each side of the body, and a fourth (in one case two—fig. 280, *c*) at the front, which may perhaps symbolize the head. The five duck pots dating from Glaze II to Glaze IV lack the "wings" and "heads"; but the "tail" is indicated, in two cases (fig. 281, *d*, *f*), by a slight thickening and extra prolongation of the body. They are all of plain ware. The orifice of the duck-pot at all periods is normally more or less oval, its longer axis being at right angles to the extension of the vessel's body.

To what use was the duck-pot put? All the Pecos specimens are made of the

[1] It so happened that all these graves could either surely be dated by decorated bowls or assigned with reasonable certainty from their position in the rubbish.

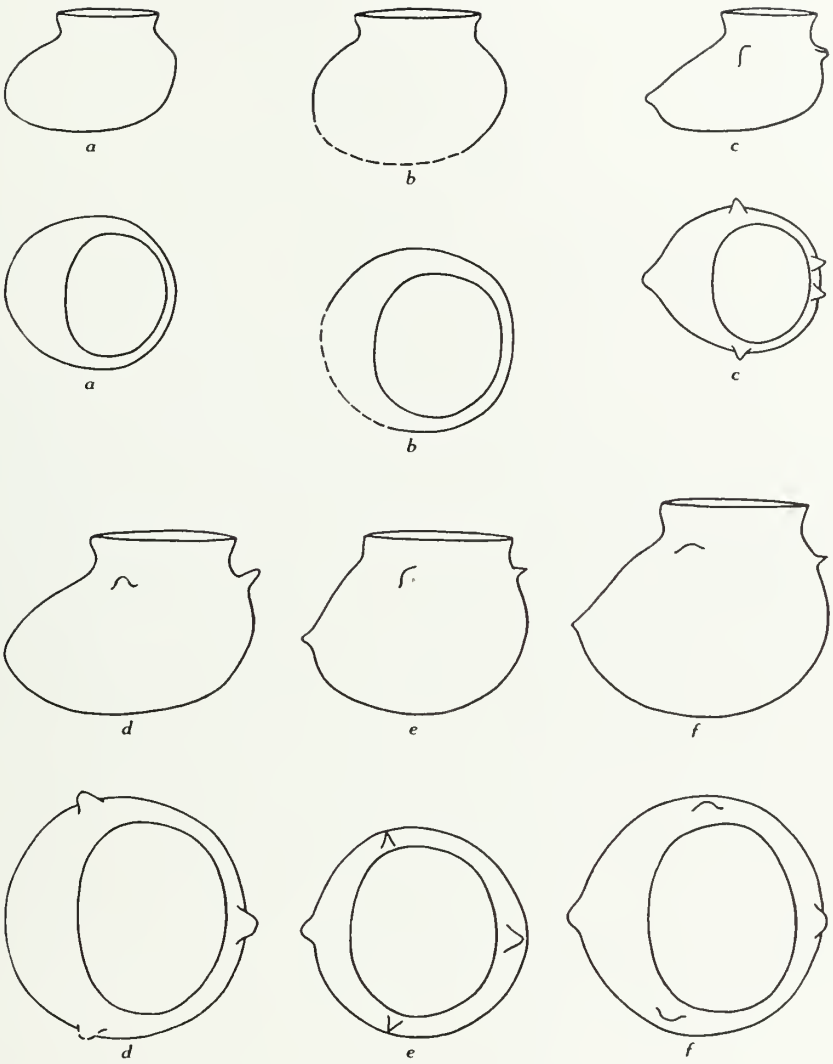


Fig. 280. Culinary ware. Duck-pots. Period assignments—*a:* Glaze IV. *b:* Glaze IV. *c:* Glaze I Yellow. *d:* Probably Black-on-white or Glaze I. *e:* Probably Glaze I. *f:* Black-on-white. For photographs of *a* and *f*, see fig. 278, *d* and *f*. (1/7)

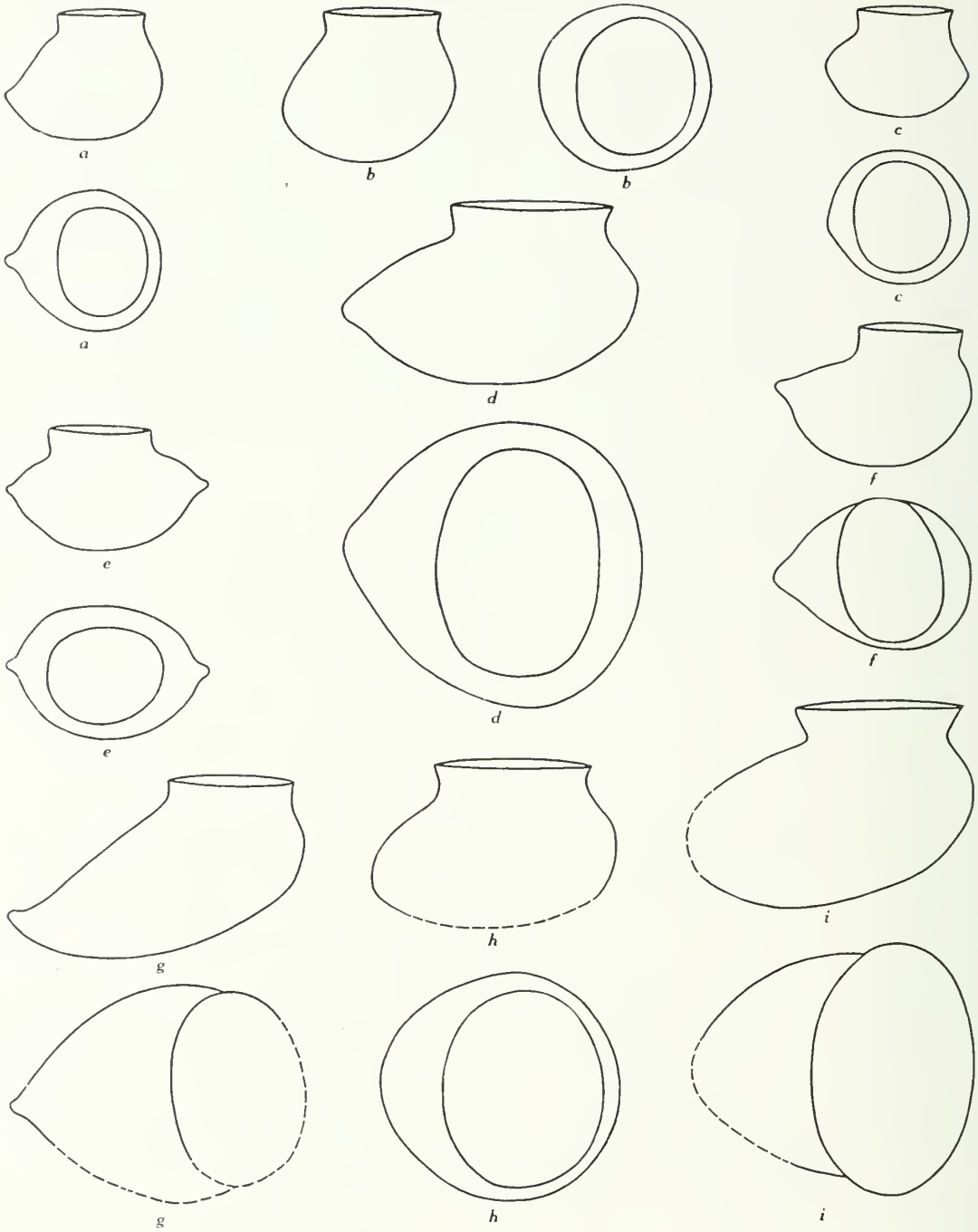


Fig. 281. Culinary ware. Duck-pots. Period assignments—*a:* Glaze I Red. *b:* Glaze III-IV. *c:* Glaze I-II. *d:* Glaze III. *e:* Glaze I-II. *f:* Glaze III-IV. *g:* Probably Black-on-white, not later than Glaze I Red. *h:* Glaze III. *i:* Period uncertain. For photograph of *f*, see fig. 278, *e*. (1/7)

same paste as the contemporary cooking jars; most of them bear traces of soot. It is therefore to be supposed that they served some culinary purpose. I have read somewhere, or perhaps heard it suggested, that the laterally elongated body might have allowed the heaping of coals over that part of the container in order to apply heat to the top as well as to the bottom and sides. If this had been the purpose of the extension one would expect it to be consistently longer than it actually is. Be that as it may, the Southwestern duck-pot did not originate as a culinary vessel, for the earliest examples, from Modified Basket Maker and early Developmental Pueblo, are all of non-culinary ware[1]. The duck form, indeed, was never made, as far as I know, for cookery, save in the Rio Grande. As a decorated vessel it was produced in limited quantities during the Great Pueblo and Regressive Pueblo periods in the San Juan, Upper Gila, and Little Colorado areas.[2] It does not seem to have occurred on the Mimbres. All decorated duck-pots more or less resemble the Pecos specimens in possessing an elongated body; and many of them bear small "wing" and "tail" nubbins. But they usually have a handle extending from the orifice to the upper part of the body. As the oldest examples are no more realistic than later ones, it appears certain that the form is not a conventionalization of an original effigy pot. There are, it is true, a few real bird effigies from ancient horizons[3] but they can hardly be considered ancestral, because highly conventional duck-pots occur with them[4]. I am therefore inclined to believe that the first vessels with elongated body were copies of some earlier non-avian container (gourd, leather sack, bladder, or whatnot); that their shape eventually suggested that of a bird; and that the resemblance was enhanced by small plastic additions. We have much collateral evidence, from pictographs and from painted decoration of pottery, that Southwestern art was intensely resistant to true realism.

The duck-pot for culinary purposes was, as has been said, apparently restricted to the Rio Grande. A specimen from the Pajarito is figured by Hewett; and two from the Chama by Jeancon[5]; they are of Glaze III or Glaze IV date and, like the later Pecos examples, have no "wing" nubbins; the "tail" of the Pajarito vessel bears a rounded protuberance.

There are no Glaze duck-pots in the Pecos collection. It is to be suspected, however, that they occasionally were made, as we have one or two conical fragments which closely resemble the "tails" of some of the black pieces. Jeancon illustrates a Biscuit sherd from the Chama which, from the length and flatness of the single remaining "wing," seems to have emanated from a somewhat more realistically rendered bird pot.[6]

[1] Morris, 1927, pp. 169, 180; fig. 16, a-e; Roberts, 1930, pp. 102-104; fig. 19, h-k.
[2] See references given by Roberts (1930, p. 104).
[3] Roberts, 1930, fig. 19, *j*, *k*.
[4] Roberts, 1930, fig. 19, *h*, *i*.
[5] Hewett, 1906, pl. XIV, *c*; Jeancon, 1923, p. 38.
[6] 1923, p. 38, right-hand specimen.

BOWLS

Sherds from bowls made of the same clay used for cooking pots were rare, though it is possible that a certain number of them escaped notice during the preliminary sorting in the field. Six bowls of this sort, however, were found in graves of Black-on-white to Glaze III date (fig. 278, *a-c*). All are small (6½ to 7¾ inches in diameter; capacities 1 to 1½ dry quarts—1.1 to 1.65 litres) and all are plain surfaced with no trace of corrugation. The rims are direct and unthickened, the lips carelessly rounded. These specimens seem to have been intended from the beginning to be bowls. They do not give the impression, in spite of their rather crude workmanship, of being, like the Forked Lightning black bowls, the lower parts of small jars whose upper parts went wrong during the moulding process.

TRADE WARES

Pottery which can be shown to have reached a site from any outside source is of high archaeological value, for it provides information as to the extent of exterior contacts and evidence as to time relations between cultures. Trade specimens from a well stratified ruin, such as Pecos, are particularly useful, because they may often be assigned to definite horizons and so permit chronological correlation of ceramic developments over large areas. Careful watch was accordingly kept, during the excavations, for all material which differed in any way from local standards; every foreign-looking sherd was saved, and attempt was made to determine the exact stratigraphic provenience of every piece. This, however, was not always successful, as a certain number of specimens remained unrecognized until the general digging sherds were washed. But even so, the use of sherd-boxes labelled by trench or room (Vol. I, p. 9) usually allowed reasonably satisfactory identification of the approximate horizon of any given piece. Several hundred trade sherds, and a few more or less complete vessels, were recovered.[1]

As there are, in most cases, better descriptions of the trade wares already in print than could be prepared from the limited and fragmentary material from the Pecos Valley, the reader is referred to them by means of footnotes. But where adequate publication has not yet been made; or where our pieces seem to add information not recorded elsewhere, brief characterizations are appended. The specimens have all been kept together at Andover, where they are available for examination by, or loan to, properly qualified students.

There follows a list of intrusive wares found at Pecos and other sites in the valley:

FORKED LIGHTNING RUIN

Mimbres Black-on-white (??)	1
Chaco Canyon Black-on-white (?)	1
Mesa Verde Black-on-white	3
Chupadero Black-on-white	10
Tularosa Filletted	1
St. Johns Polychrome	195

LOMA LOTHROP

Chihuahua Polychrome	1

ROWE

Chupadero Black-on-white	1
Heshotauthla Polychrome	12

[1] Since the above was written Miss Shepard has shown that large quantities of Black-on-white, Glaze I, Biscuit, and other types of pottery were probably imported. These, however, are all Rio Grande wares, none of which presumably came from great distances.

	PECOS
Mesa Verde Black-on-white (?)	3
Chupadero Black-on-white	1
St. Johns Polychrome	6
Heshotauthla Polychrome	40
Jeddito Black-on-yellow, Sikyatki Polychrome	165
Sankawi Black-on-cream	4
Potsuwi'i Incised	22
Gobernador Polychrome	1
Hawikuh Recent Glaze	1
Zuñi Polychrome	8
Tsia Polychrome	75
Acoma Polychrome	2
Panhandle Paddled	1
Sherd from Central Mexico (?)	1

MIMBRES BLACK-ON-WHITE (?)[1]

Four sherds collected at the Forked Lightning ruin were suspected to be from the Mimbres. Several years ago they were shown to Mr. and Mrs. Cosgrove, authorities on Mimbres pottery, who believed one to belong to that group; as to the other three they were uncertain. The one fragment, presumably put away for safe-keeping, was so successfully segregated that it cannot now be found.[2] The three questionable pieces were submitted to Miss Shepard for study; they prove to be sherd tempered and therefore different from any known Mimbres ware. This confirms the Cosgroves' doubts. As the single likely piece is unavailable for re-examination, the trade status of Mimbres pottery in the Pecos valley must be considered questionable. A Mimbres sherd, however, has been found at a Black-on-white site (L. A. 10) on Galisteo Creek, New Mexico, a few miles west of Pecos.[3] The ruin in question is probably roughly contemporaneous with Forked Lightning.

CHACO CANYON BLACK-ON-WHITE (?)

A single small sherd from Forked Lightning has a suspiciously Chaco look (fig. 283, *j*). It is part of a cylinder about 3 inches in diameter, apparently the neck of a pitcher. The decoration is neatly executed square checkerboarding.[4] Miss Shepard informs me that the specimen is sherd tempered. She states that many

[1] The best works on Mimbres pottery are: Bradfield, 1931; Cosgrove, 1932. Many specimens have also been figures by Fewkes (see bibliography in Cosgrove, 1932).

[2] This is the specimen referred to in Vol. I, p. 19 and in Cosgrove, 1932, p. 112.

[3] Mera, 1935, p. 15.

[4] In shape and design (save for lack of dots in the checkerboarding) the sherd conforms exactly to the standards of a Chaco pitcher illustrated in Kidder, 1924, pl. 22, *c*; see also pitchers figured by Pepper (1920).

Chaco types are sherd tempered, but that this quality in itself is not sufficient evidence upon which to base a positive identification. If it should indeed be from a Chaco site, it would still provide little information as to the date of Forked Lightning, for the actual, as distinguished from the relative, chronology of the Chaco wares has not yet been established.[1]

MESA VERDE BLACK-ON-WHITE

Much of the Black-on-white pottery of Forked Lightning bears an illusive resemblance to the earlier, less specialized, and not as yet definitely characterizable Pueblo wares of the northern San Juan. Such likenesses, however, seem to be due to San Juan influence exerted during the formative period of Forked Lightning Black-on-white, rather than to contemporary artistic stimuli; and the specimens which exhibit them were doubtless mostly of local, or at least regional, manufacture.[2] The later, specialized, Mesa Verde style, easily and certainly identifiable even in small fragments, is represented by three fragments from Forked Lightning. Two were picked up on the surface and one was taken from the uppermost cut of Test D (Vol. I, pp. 28-30).

Because of its marked peculiarities, Mesa Verde Black-on-white has long been recognized as a distinct style.[3] Its principal diagnostic traits are: well polished, pearl-gray slip; square bowl-rims, usually dotted; exterior decoration of bowls. Its focus is in the country north of the San Juan from the Animas on the east to the McElmo drainage on the west. In the western part of the area, and extending still further westward to Montezuma Creek and beyond, there is found a less well-marked but obviously allied ware, which may be either peripheral to, or earlier than, standard Mesa Verde pottery. My belief that it was early led me to call it, in a former publication, Proto-Mesa Verde.[4] There are also extensions of the standard ware, apparently of rather late date, into Chaco Canyon and Canyon de Chelly. Morris has recognized a very degenerate terminal phase.[5]

Mesa Verde pottery can be assigned to the later part of the Great Pueblo period. Morris's excavations at Aztec proved that it succeeded the typical Chaco

[1] The literature of Chaco ceramics is surprisingly scanty. Pepper (1920) figures a number of specimens. Kidder (1924, pp. 51-53) gives a brief characterization which, however, fails to take into account the important chronological differences which are now known to exist. F. H. H. Roberts, Jr. has prepared a comprehensive report upon Chaco pottery, but, through no fault of his own, this remains unpublished. Miss Hawley has recently issued a paper in which the pottery types of Chetro Ketl are classified and their chronological relationships discussed (Hawley, 1934).

[2] For discussion of the relationship between San Juan and Pecos Black-on-white pottery see Amsden, Vol. I, pp. 19-21. Mera (1935) believes Mesa Verde wares to have exerted considerable influence upon the development of certain Rio Grande Black-on-white types.

[3] Typical examples are figured in Nordenskiold, 1893; Fewkes, 1909, a; 1911; Morris, 1919. Kidder (1924, pp. 61-64) gives a brief characterization; Morris's forthcoming monograph on the archaeology of the La Plata drainage, to be published by Carnegie Institution of Washington, will be the standard work upon Mesa Verde pottery.

[4] Kidder, 1924, p. 65.

[5] To be described in the above-mentioned publication.

wares at that site.[1] Accurate dating by dendrochronology will eventually be possible. Certain facts are already in hand. The cliff-houses of the Mesa Verde itself contain timbers cut between 1073 and 1262 A.D.; certain parts of the Mummy Cave ruin in Canyon del Muerto, Arizona, which surely were erected by Mesa Verde people, yield dates from 1253 to 1284.[2] No evidence of building activity by Mesa Verdians subsequent to 1284 has yet been discovered, and I believe that by 1300 their culture was on the way to disappearance.

The three bowl-sherds from Forked Lightning (figs. 282; 283, *h*, *i*) are unmistakably Mesa Verde. They have all the earmarks: smooth, pearl-gray slip; flat-lipped, dotted rims; exterior decoration. While no pieces as surely identifiable as these were

Fig. 282. Mesa Verde Black-on-white. Interior (left) and exterior (right) of two bowl sherds from the Forked Lightning ruin; the decoration of the rim is shown above the exterior of each sherd. For photograph of exterior of *b*, see fig. 283, *i*. (1/3)

found at the main Pecos ruin, that site yielded a mug and a little canteen (Vol I, fig. 4, *d*, *h*) which were almost certainly importations, and which have a strong Mesa Verde look. There is also a sherd from a small-mouthed vessel, perhaps a pitcher, that may well be of Mesa Verde origin.

The chronological aspects of the development of Mesa Verde pottery are not as yet sufficiently well understood to permit assignment of the Forked Lightning sherds to any sub-period of the Mesa Verde culture. They certainly do not belong, however, to either the Proto-Mesa Verde or the degenerate groups. All that can now be said is that their presence indicates occupancy of Forked Lightning during some part, at least, of the 12th or 13th Centuries.

CHUPADERO BLACK-ON-WHITE

Ten sherds came to light at Forked Lightning (one from Test D, Cut 2; see Vol. I, pp. 28-30); one from Rowe, and one from Pecos.[3]

Chupadero Black-on-white was named and described by Mera; it is also well described by Cosgrove.[4] Its diagnostics are: flat, disc-like bowl bottoms; interiors

[1] Morris, 1921, p. 136. [2] Douglass, 1929, p. 743.

[3] Identifications by Kidder, Miss Shepard has found additional sherds in the Forked Lightning and Pecos collections.

[4] Mera, 1931; Cosgrove, 1932.

Fig. 283. Trade wares and local wares. *a:* Zuñi Polychrome. *b, c:* Acoma Polychrome. *d-g:* Fragments of terraced prayermeal (?) bowls with glaze decoration (probably local). *h, i:* Mesa Verde Black-on-white from Forked Lightning ruin (for interior of *i*, see fig. 282, *b*). *j:* Chaco Canyon (?) Black-on-white (Forked Lightning). *k:* Casas Grandes Polychrome (Loma Lothrop ruin). *l:* Chupadero Black-on-white with decoration in thin glaze (Dick's ruin). *m-o:* Tsankawi Black-on-cream. (Width of *b*, 4 1/4 inches)

of small-mouthed vessels and exteriors of bowls very roughly scraped; rusty-black pigments. The focus of the ware seems to have been in southern Torrance and eastern Socorro Counties, New Mexico.[1] It has not been reported west of the Rio Grande, save in the Mimbres valley; but it occurs as far to the east as Santa Rosa, New Mexico, south to El Paso and into Chihuahua.[2] Mera's ceramic survey of New Mexico and one which E. B. Sayles is conducting for Gila Pueblo in the southeastern Pueblo field will serve to define the home range and to delimit the apparently very wide trade-diffusion of this pottery.

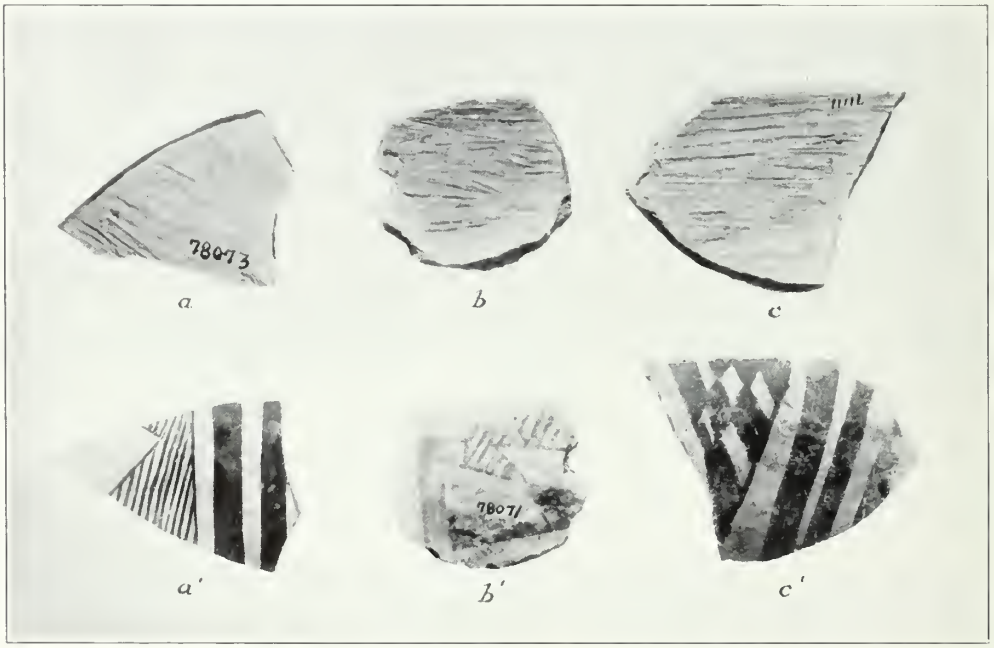


Fig. 284. Chupadero Black-on-white. Interior (above) and exterior (below) of three sherds from small-mouthed vessels. Note heavy scraping marks which are characteristic of this ware. *a*, *b*: Forked Lightning. *c*: Pecos. (Width of *c*, 2½ inches)

The Forked Lightning, Rowe and Pecos specimens, all from vessels with restricted orifice, are typical in that their inner surfaces are deeply scraped and that their pigments are, for the most part, rusty-black (fig. 284). The decorations check closely with those shown by Mera and Cosgrove; there are the same broad lines and the same opposed solid and hatched dentate elements meeting at the points (fig. 284, *b'*), which Cosgrove states to be particularly characteristic.[3] There are no rim sherds, but at Dick's ruin, a late Black-on-white site, there was found a neck frag-

[1] Mera, 1931, p. 1.
[2] Cosgrove, 1932, p. 98, footnote; information from Mera.
[3] Cosgrove, 1932, p. 97.

ment which has the typical Chupadero outcurve and heavy, horizontal dashes (fig. 283, *l*).[1] The paint of this specimen, however, is a very thin glaze.[2]

In age, Chupadero Black-on-white may be assigned to the later part of the Great Pueblo period and the early part of the Regressive Pueblo period. It occurred in the uppermost deposits of the Great Period Swarts ruin on the Mimbres;[3] it is so often found in surface association with Agua Fria Polychrome, Gila Polychrome and Chihuahua wares[4] that there can be little doubt that it survived well into the Regressive Pueblo period. I do not believe, however, that in the form described by Mera and Cosgrove it could have persisted to a period anything like as late as Glaze VI, as is supposed by Mera to have been the case.[5] Its presence at Forked Lightning, while by no means a precise indication of the age of that site, suggests that it was occupied toward the end of the Great Period.

Miss Shepard has supplied the following technological notes:

"The pigment gives a strong test for iron but none for manganese. It is variable in hardness, occasionally being vitrified, while the softest specimens are 3-, although abrasion was not noted. The surface is generally matte in appearance but some of the harder paints have a distinct luster from incipient fusion, though they may be without appreciable relief or noticeable evidence of vitrification. In all but the vitrified paints the iron is oxidized upon heating without the use of hydrofluoric acid. Except for the fused specimens the paint is magnetic. Colors include: blacker than 15''''m (Blackish Mouse Gray), 17''''k to i (Chaetura Drab to Hair Brown), 13''''k (Fuscous), and rarely 13'''k (Natal Brown). Viewed megascopically, the paste appears fine grained and moderately to heavily tempered. In some specimens there may be seen irregular, dull black or dark gray particles fine to medium in size. The paste color is uniform from core to margin and includes the range of grays between 15''''b and d (Light and Pale Mouse Gray) and Pallid Neutral Gray. Three sections examined petrographically contain fine, dark sand-tempered potsherd fragments and abundant fine mineral inclusions which differ in the three sections. In one quartz preponderates over feldspar, in a second feldspar grains are more numerous than quartz, both contain fragments of hornblende and augite. The third section is characterized by fragments of cryptocrystalline rock in addition to potsherd. Slips are 15''''f (Pallid Mouse Gray) and whiter. They are thin (0.02 to 0.10 mm.), characteristically streaked and modified by the underlying paste color. The surface is smooth, and faintly lustrous. Marks of a smoothing tool are seldom seen, but the streaking of the slip resulting from uneven application indicates horizontal finishing strokes."

[1] See Cosgrove, 1932, p. 97; Mera, 1931, fig. 1.

[2] Both Dr. Mera and Mr. Gladwin, who have kindly examined the sherd, believe it to be Chupadero.

[3] Cosgrove, 1932, p. 110.

[4] Mera, 1931, p. 3; Cosgrove, 1932, p. 110.

[5] Mera, 1931, p. 3.

TULAROSA FILLETTED

One sherd came from the lowest stratum of Test D, Forked Lightning (Vol. I, pp. 28-30).

No classification has yet been published of the very interesting and important category of pottery to which this specimen belongs; nor have its relationships to the various decorated wares, with which it is associated, been determined. Its range, too, is not known.[1] The material in question consists of bowls, with brownish or reddish exteriors and polished black interiors; the exteriors are finely and tastefully corrugated, often in a narrow band just below the rim.[2] The focus of the ware appears to lie in the upper tributaries of the Gila in southwestern New Mexico and southeastern Arizona; it is there associated with Tularosa Black-on-white.[3] It is a product of the Great Pueblo period and, I am inclined to believe, rather late.[4]

The Forked Lightning fragment (fig. 300, *a*) is from a bowl about 12 inches in diameter. The interior is well polished, but not highly lustrous, black. The lip is rounded, with an outside bevel which reaches the top of a 2¼-inch band of corrugation. The band is bordered above and below by sets of three waved corrugations; between them are twenty fine, straight, unindented corrugations, occupying a space of only 1⅝ inches. The corrugations have been worked over with a tool of some sort, presumably a rubbing stone, which has dulled their edges and, on the highest parts, flattened and even polished them. The uncorrugated lower wall has also been polished, but its surface is less smooth than the interior. In color, the exterior is brown (Ridgway's Army Brown—13″″i, for the polished parts of the ribs; darker and duller where the clay is unrubbed).

The chronological significance of this Forked Lightning sherd cannot be determined until we know more concerning the age of the category to which it belongs, and particularly as to the relative ages of the subtypes into which it is doubtless divisible. All that can now be said is that its presence in what appears to have been one of the earliest strata of Forked Lightning would indicate that that site cannot well be older than, say, the middle of the Great Pueblo period. But to attempt to date the specimen in terms of years would be to indulge in pure guesswork.

ST. JOHNS POLYCHROME

A surprisingly large amount of this pottery occurs at the Forked Lightning Ruin (nearly two hundred sherds were collected); six sherds were found at Pecos proper.

[1] The ceramic survey by Gila Pueblo will result in acquirement of much information regarding Tularosa Filletted. Readers of the present book should consult the *Medallion*, in which series papers bearing on this ware will doubtless appear.

[2] For illustrations of a few pieces, see Kidder, 1924, pl. 44; see also Hough, 1914, pp. 40, 41.

[3] Gladwin, W. and H. S., 1931, pp. 32-35. Mera (1935) has shown that pottery of this general type reached the Rio Grande in southern New Mexico.

[4] See Cosgrove, 1932, p. 111.

St. Johns Polychrome, formerly called "Little Colorado Black-and-white-on-red" or, still more loosely, "Little Colorado" ware was given its present name in 1931 by the Gladwins.[1] It appears almost exclusively in the form of bowls, which are slipped red or orange-red within and without; interior decoration is in matte black paint, exterior decoration in white.[2] The "home range," so to speak, of the ware lies, according to the Gladwins, within a fifty-mile radius of St. Johns, Arizona;[3] Roberts states that it centres between St. Johns and Holbrook, Arizona.[4] The focus is therefore evidently in the southeastern tributaries of the Little Colorado. But, as has been pointed out by various observers, it is the most widely distributed of all Southwestern pottery. It occurs in apparently considerable quantities on the Blue, San Francisco and Tularosa rivers, all northeastern tributaries of the Gila;[5] as well as in the northeastern affluents of the Salt.[6] There are records from the middle Gila,[7] from Chihuahua,[8] from the Mimbres.[9] It appears east of the Rio Grande in the general Jornada del Muerto district;[10] also at Forked Lightning ruin in the upper Pecos Valley. The farthest known eastward occurrence is at Tecolote, near Las Vegas, New Mexico.[11] The red ware from ruins in the Taos valley mentioned by Jeancon[12] might well be St. Johns Polychrome. There seems to be no record for the Pajarito Plateau nor for the drainage of the Chama. Passing to the San Juan, we find that it is present at the Aztec ruin,[13] in Chaco Canyon[14] and on the Mesa Verde.[15] So far as I am aware, none has been noted from northern affluents of the San Juan west of the Mesa Verde, nor from any site in Utah. South of the San Juan, however, it crops up in the Chinlee and in Canyon de Chelly;[16] but not, apparently, in the Kayenta country. I have found fragments in sites about the Hopi mesa; ruins in the vicinity of Flagstaff, Arizona, produce specimens.[17] It seems not to be present in the drainage of the Verde.[18]

The extraordinarily extensive diffusions indicated by the foregoing delimitation of the now known frontiers of penetration is most plausibly attributable to trade, St. Johns Polychrome being one of the most strikingly colored and attractive of all Southwestern wares. But pottery was common household stuff in every part of the area; moreover, it is both bulky and fragile. So one must at least visualize the possibility that the product in question may actually have been manufactured in some of the localities, even at great distances from the Little Colorado, where it is found in considerable quantities. Forked Lightning is a case in point. For it seems almost incredible that so many bowls as were evidently once in use at that village

[1] Gladwin, W. and H.S., 1931, p. 36.

[2] The Gladwins, in the paper naming the ware (1931, pp. 36-40), reproduce one specimen in color (Pl. XXXV) and several in halftone (pls. XV, *c*; XXIII, *d*; XXVIII; XXXVI, *c*, *d*; XXXVII). Other fine color plates are in Hough, 1903, pls. 35; 46, *b*; 47; 49, *b*; 63. F. H. H. Roberts, Jr. illustrates one in color (1932, pl. 31, *b*; halftones, pls. 37, 38).

[3] 1931, p. 37. [4] 1932, p. 119. [5] Hough, 1914, pp. 43-45. [6] Hawley, 1930, p. 531.

[7] Gladwin, W. and H. S., 1931, p. 37.

[8] Gladwin, W. and H. S., 1931, p. 37; also noted during explorations of the author near Corralitos.

[9] Cosgrove, 1932, p. 92. [10] Mera and Stallings, 1931, p. 9. [11] Excavations of Phillips Academy.

[12] 1929, p. 26. [13] Morris, 1919, p. 71; fig. 45, *b*. [14] Roberts, 1932, p. 110.

[15] Nordenskiold, 1893, p. 84, pl. XXXIII. [16] Explorations of the author.

[17] Information from E. W. Haury. [18] Gladwin, W. and H. S., 1930.

would have been carried so far. If they were, indeed, of local make, their presence must have been due either to the spread of the style; or to the immigration of western potters. These points should, if possible, be settled; because, on the one hand, they relate to the highly important general subjects of aboriginal barter and culture-trait diffusion; and, on the other, they bear upon specific questions of trade-routes and movements of people, and are thus of significance for the reconstruction of Southwestern history. Comparative technological studies, resulting in accurate determination of the physical components of St. Johns Polychrome and location of their sources, can give us at least a start toward solving the problem. My present feeling, based on the strong individuality of the ware in paste, slip, and decoration; and on the fact that the Black-on-white pottery which accompanies St. Johns Polychrome at the Little Colorado ruins does not seem to have had anything approaching an equally extensive range; is that it was made in a single fairly restricted area and that trade was primarily responsible for its wide diffusion.[1]

But no matter how the bowls may have reached their ultimate far-flung resting places, their chronological meaning is the same. The finding of a sherd of this ware indicates, subject to the checks applicable to all archaeological evidence, approximate contemporaneity of the deposit in which it occurs with all others producing the same material. It is, accordingly, perhaps the best single time-reckoner available for the Southwesternist. Its value is enhanced by its bright color, which brings it quickly to the eye of the sherd gatherer; and by the marked peculiarities of paste and pattern which permit the confident identification of even very small fragments.

Because of its great potential usefulness, St. Johns Polychrome deserves meticulous study. It is doubtless susceptible to classification into sub-types, regional or chronological, or both. Even the relatively limited collection from Forked Lightning shows variations of probable significance. These, of course, can best be worked out in the Little Colorado, a hitherto much-neglected region, but one whose importance is now being stressed by the Gladwins, and whose manifold archaeological problems are under intelligent study by Gladwin and Haury of Gila Pueblo, Colton and Hargrave of the Museum of Northern Arizona, and F. H. H. Roberts, Jr. of the Smithsonian Institution.

The age of St. Johns Polychrome is naturally of outstanding interest. The question of its position relative to the other principal categories of Little Colorado pottery was first satisfactorily worked out by Spier, who showed that it came into being toward the close of Black-on-white times and antedated the period of Glaze.[2] Cross-finds in other regions clearly indicated that it should be assigned to the latter part of the Great Pueblo period. But its actual date in terms of our calendar, which was so desirable for bringing precision into the archaeology of the Little Colorado; and which, because of the ubiquitousness of the ware, was essential for fitting many other ruins into their proper chronological niches, could not be ascertained until the

[1] Since the above was written Miss Shepard has demonstrated the probability of a very active regional trade in pottery. Her findings make it seem not at all improbable that so attractive a ware as St. Johns Polychrome should have been widely distributed in barter.

[2] Spier, 1917.

development of dendrochronology.[1] By this system Haury has now been able to demonstrate that St. Johns Polychrome was in use at the Showlow ruin on Clear Creek, a southern tributary of the Little Colorado, during the early years of the 13th Century, but that it had gone out of fashion before 1275 A.D., by which time it had been supplanted, in the Clear Creek region at least, by Pinedale Polychrome.[2] We thus have a probable terminal date somewhere toward the middle of the 13th Century, say about 1225 to 1250 A.D. The time of its origin is still problematical, but from what little we know of the average life of Southwestern pottery styles it seems unlikely that so highly specialized a ware could have persisted relatively unchanged for much more than a hundred years. This would throw its beginning back to 1125 to 1150 A.D. The only evidence pointing towards greater age is that of Roberts, who recovered St. Johns Polychrome from the Village of the Great Kivas, in the Zuñi country, a ruin containing charcoal of the early 11th Century (1015-1030 A.D.).[3] The excavations there, however, disclosed certain Black-on-white vessels which look much older than the Black-on-white normally accompanying St. Johns Polychrome; and so, although the burned roofs which produced the charcoal lay above specimens of St. Johns Polychrome;[4] and although these roofs covered what were obviously the latest-built parts of the pueblo; and although all indication of a long period of abandonment eluded Roberts' careful search (and there is no field worker whose observations are more fully to be trusted); yet I nevertheless feel that the place must actually have stood vacant for at least a hundred years and that the 11th Century timbers were re-used in dwellings erected not earlier than the middle of the 12th Century. Roberts' excavations at the Grubb site, near Allantown, Arizona, which are yielding invaluable information regarding the early periods in the region, will, when they are extended to the large, late ruin which exists there, doubtless throw much light on the highly important problem of the date of origin of St. Johns Polychrome.

The Pecos Valley material is almost all from the Forked Lightning ruin, where there were collected nearly two hundred sherds, one complete bowl (fig. 285, *a*) and large parts of another (fig. 286). Although this seems an unduly great number of specimens to represent a trade ware, particularly one which presumably came from a long distance, the sherds actually comprised a very small percentage of the total ceramic content of the site. They are the cullings from many thousand fragments, both on the surface and in the earth turned during excavation. My only accurate figures are for the stratigraphic tests, in each of which Mr. Amsden found St. Johns Polychrome, but in none of which did it rank as high as 1%.[5]

[1] Douglass, 1929, 1935.
[2] Haury and Hargrave, 1931; Haury, 1932.
[3] Roberts, 1932.
[4] Personal information from Dr. Roberts.
[5] Vol. 1, pp. 27-36, footnotes.

GENERAL CHARACTERISTICS

The ware is three-color; matte black and matte white paint on red backgrounds. Designs are intricate and well spaced, but brushwork is sloppy. Save for a single sherd from the hollow handle of a bowl-and-handle ladle, no form but the bowl occurs. The interiors are decorated with the matte black paint; their exteriors with the matte white. There is one sherd with a fine white line bordering a solid black figure. The slip varies greatly in color. It is a heavy coat, the thickest that I can remember to have seen on any Southwestern pottery. Well finished, though by no means glossy, it has a pleasant, "even" feel. Tool marks are usually imperceptible; fine crackling is common, but not universal. St. Johns Polychrome may be called red or orange-red. But the range of surface hue is broad. The brightest pieces, which are not abundant, approximate Ridgway's Vinaceous Rufous (7′i). From that very attractive color the slips pass into Ferruginous (9′i) and Cinnamon Rufous (11′i), then become more pallid, i.e., Orange Cinnamon (13″). There are specimens of Pinkish Cinnamon (15″b). The commonest are Rufous to Ferruginous (9′ to 9′i). The exterior of any given piece usually matches the interior fairly closely. The black pigment on the reddest slips is sharply defined and bluish or slightly slaty, sometimes with a very faint non-vitreous sheen.[1] On the yellower slips it is a duller, weaker black. Many specimens bear a faded-looking paint, between Walnut Brown (9″k) and Burnt Umber (9″m) or Natal Brown (13‴k), which seems to have little or no body and actually to sink into the slip. On an occasional sherd a slight luminosity borders the painted lines, as if some material in the pigment had worked out into the slip. The collection consists, for the most part, of pieces so small that one cannot tell whether these variations held constant over the whole vessel; there is some evidence, however, that they did.

The white paint upon the exterior of the bowls is much more uniform. Rather carelessly brushed on in broad strokes, it lies upon, rather than amalgamates with, the slip. At its rare best it is thick and pure white; but when thin or when, as is very often the case, it has partly rubbed away, the red shows through; not seldom it has so nearly disappeared that one is in doubt as to its former presence.

Miss Shepard has supplied the following technological notes:

"The paste appears coarse grained and moderately tempered. White or buff colored sherd fragments are plainly visible to the naked eye in all but a few specimens. In general the pastes which are fully oxidized seem to be finer in texture than those which have dark cores but in most cases this impression is produced by lack of color contrast between sherd temper and clay base in the former class. The combination of coarse temper and dense paste produces a ragged, irregular fracture. Dark Neutral Gray, *k*, to Pallid Neutral Gray, *f*, cores and narrow whitish or buff—13″*d* (Light Vinaceous-Cinnamon), 15″*e*, and 21‴*f* (Pale Olive-Buff) slightly grayed—margins are typical. A few sherds are fully oxidized and the color range of these is the same as that of the margins. Examined petrographically the sherd tempering

[1] Paints partially vitrified are described below, p. 362.

fragments are found to be similar to the clay base and often contain sherd inclusions. Fine quartz and feldspar grains are sparse and seldom exceed 0.15 mm. in diameter. Few other mineral inclusions were noted, a splinter of brown hornblende, a grain of zircon. The slip is sandy and contains numerous inclusions of quartz and feldspar averaging 0.08 mm. in diameter. The thickness of the slip is variable but on the majority of sherds it is between 0.25 and 0.35 mm. in thickness. The thinnest specimen found was 0.14 mm. and the thickest 0.56 mm. Paint surfaces are smooth and without relief and it is particularly difficult to obtain material for analysis. Six specimens were tested by first treating the surface with hydrofluoric acid and scraping off the loosened paint after the acid had dried. Even with this procedure clay was included in the sample and it was necessary to test slip treated in the same manner as the paint as a control. The paint samples gave no test for manganese but in all cases a very much stronger test for iron than was obtained from the slip."

BOWL SHAPE

Specimens ran, according to calculations based on fragments, from 8 to 12 inches in diameter. Pieces 10 to 11 inches in diameter would seem to have been by far the commonest. Our whole bowl is 11½ inches wide by 6 inches deep, the *orifice-depth index* being accordingly .52; its *capacity* is 6 dry quarts (6.6 litres). The less complete one measures 8¼ by 4 inches; *diameter-depth index* .48. In general contour, these two bowls seem typical. They are fully rounded and did the vessel wall not curve a little inward at the top, thus throwing the point of greatest diameter somewhat below the rim, they would be almost perfectly hemispherical. The *rim* (fig. 287) is essentially direct, although there occurs in many pieces the least suspicion of an outcurve on the exterior just below the lip (*e-g*). The lip is characteristic: the highest point lies at the outer edge, whence it bevels a little downward to join the inner surface of the vessel wall. The outer edge is sharper than the inner, but both are rounded. The modelling in profile is suave, rather than angular. Evenly rounded lips, with no bevel, are unusual (*i*); even rarer are square-lipped rims (*j*); there is but one piece which shows appreciable thickening (*k*). Vessel walls are 3/16 to ¼ inch in thickness.

GENERAL DECORATIVE FEATURES

Slip extent. Red covers the whole vessel, interior and exterior. The slip is often worn from the exterior bottom, revealing the usually light-colored paste. There are two sherds with exterior white slip and decoration in red lines. Roberts notes similar pieces from the Village of the Great Kivas in the Zuñi country.[1]

Zones of decoration. *Interior*: there are three sorts of arrangements: very broad band from base of bevel of lip to well toward bottom; broad decoration ending below in triangular projections, which produce an undecorated star-shaped space

[1] 1932, p. 111; pl. 27, *a*, *b*.

in the bottom of the bowl (fig. 285); all over (fig. 286). *Exterior:* upper wall from the rim downward for 3 to 4 inches (fig. 285, *a'*, *b'*). Rims are undecorated.

BOWL INTERIOR DESIGN

Unlike the relatively narrow bands composed of simple alternating units, with which we had to deal in the Pecos Glazes, the interior decorations of St. Johns

Fig. 285. St. Johns Polychrome. *a:* Bowl from Forked Lightning ruin. *b:* Bowl from Apache County, Arizona, illustrated for comparison. (Diam. of *b*, 12½ inches)

Polychrome bowls are both large and involved; they cover the greater part of the surface, many were of the all-over type. Hence they can seldom be restored from the small sherds which form the bulk of our collection. Certain general characteristics, however, are at once obvious: the rarity of bands; and the apparent total absence of

Fig. 286. St. Johns Polychrome. Fragment of bowl from Forked Lightning. (Diam. 8¼ inches)

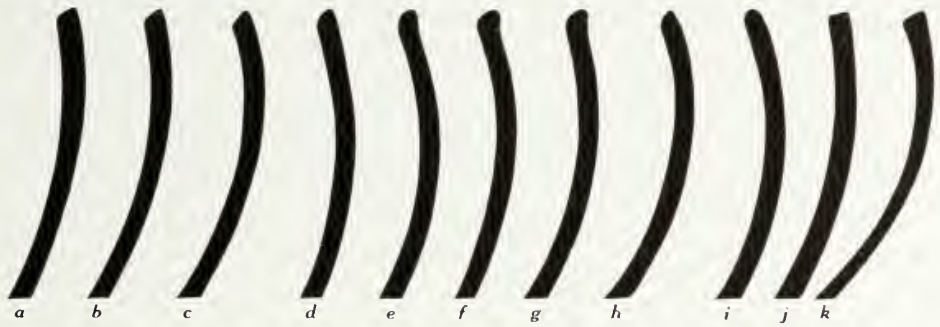


Fig. 287. St. Johns Polychrome. Bowl rim profiles. Note uniformity of curve of vessel walls. The slightly bevelled lip is typical; many rims have a faint outcurve on the exterior just below the lip (*e-g*). Rounded (*i*) and square (*j*) rims are rare. The thickened rim at *k* is unique. (1/2)

paneling in such as do occur; the frequency of curvilinear motifs; and particularly the great abundance of hatching.

BANDS

It is usually difficult to tell whether a fragmentary pattern is part of a band or of one of the band-like arrangements which leave a star-shaped space in the bottom of the bowl. We have, however, a few pieces which are certainly from bands. These

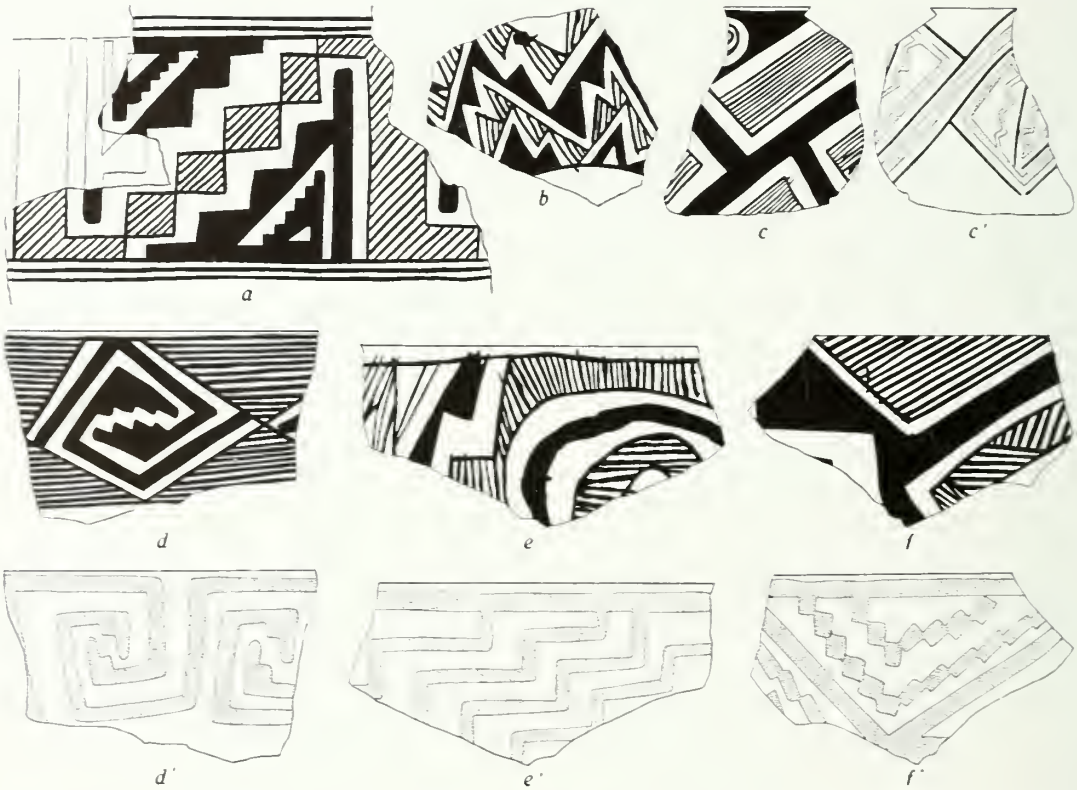


Fig. 288. St. Johns Polychrome from Forked Lightning. Bowl sherds. *a-f:* Interiors. *c-f':* Exteriors (shading represents white paint). (1/3)

indicate that in most cases there were no framing lines, the pattern terminating above and below with a single, narrow banding line. There is one example which has two narrow framing lines at top and at bottom (fig. 288, *a*) and one with three at top (fig. 289, *e*, the lower part of the band is missing). There is not a single instance of the single heavy upper framer characteristic of Pecos Glaze I.

The full pattern of the bands can seldom be made out. There is one arrangement, however, which, according to the sherds, was used a great deal. It consists of

large, elaborate black keys, alternately pendent from the upper banding line and rising from the lower. Between the keys runs a stepped hatched ribbon or a series of offset hatched squares (fig. 288, *a*). This was evidently one of the stock patterns of St. Johns Polychrome.[1] Another, represented by several sherds in the Forked

Fig. 289. St. Johns Polychrome. Interiors of bowl sherds. Sherd *i* is from Pecos, the rest from Forked Lightning. For exterior of *a*, see fig. 290, *f;* of *i*, fig. 290, *a;* of *e*, fig. 290, *c;* of *i*, fig. 290, *b* .(Width of *e*, 4⅜ inches)

Lightning collection, is made up of saw-tooth zigzags alternately in solid black and hatching (figs. 288, *b;* 289, *k*).[2] A very few bands seem to have contained no hatching (see fig. 289, *a*, *e-g*); the full patterns cannot be reconstructed.

[1] See Hough, 1903, pl. 35, *c;* Gladwin, W. and H. S., 1931, pls. XXXV, XXXVI, *c*, *d;* Roberts, 1932, pl. 37, *b*. The same pattern is also seen in Tularosa Black-on-white, Gladwin, W. and H. S., 1931, pl. XXXVI, *a*, *b*.

[2] Hough, 1903, pl. 35, *b;* Gladwin W. and H.S., 1931, p.. XXXIII, *a* (on the closely allied Wingate Black-on-red); Roberts, 1932, pl 36, *d*. Again there are Tularosa Black-on-white affinities (Kidder, 1924, pl. 34, *a*).

STAR-BOTTOM

We have a number of fragments bearing what are evidently parts of this very characteristic St. Johns Polychrome design. It forms the decoration of our one whole bowl (fig. 285, *a*). The painting starts, in all the examples, at a narrow line (analogous

Fig. 290. St. Johns Polychrome and Heshotauthla Polychrome. Exteriors of bowl sherds. *a-f:* St. Johns from Forked Lightning. *g-i:* Heshotauthla from Pecos. (Width of *c*, $4\frac{3}{8}$ inches)

to the upper banding line of the true band) drawn at the inner edge of the bevel of the rim. Pairs of elaborate interlocking stalked keys in black and hachure form the basis of a pattern whose angular lower points extend into the bottom of the bowl to produce a six-pointed star in negative or reserved space. A second bowl, from Apache County, Arizona, is illustrated for comparison (fig. 285, *b*).[1]

[1] See also Hough, 1903, pl. 47, *a*.

ALL-OVER PATTERNS

An incomplete specimen is decorated with a complicated curvilinear design in black and hachure (fig. 286). There are many sherds from bowls of the same general type.[1]

ELEMENTS OF INTERIOR DECORATION

Lines of two sorts appear: the fine and the heavy. Fine lines have a normal width of almost exactly $\frac{1}{16}$ of an inch; their principal use is in hatching. Heavy lines, such as the stalks of keys and the black parts of curvilinear designs are from $\frac{1}{4}$ to $\frac{1}{2}$ an inch wide. They were sometimes painted with a single stroke of the brush, sometimes outlined and filled. There is not a dotted, ticked, or stepped line in the whole collection of St. Johns Polychrome sherds.

Hatching is the hallmark of the ware. Almost every pattern contains some; many consist of very little else save hatching and relatively narrow black foils. The hatching is made up of the above-mentioned $\frac{1}{16}$-inch lines enclosed by bordering lines of the same or a trifle greater weight. The spaces between the lines are generally somewhat wider than the lines themselves, almost never, however, as much as twice. There seems to have been an attempt to run the hatching obliquely in relation to its borders, particularly in the filling of straight ribbon-like fields. Longitudinal hatching seldom occurs in such areas. In triangles and rectangles the lines generally parallel the longest side. The hatching of the elongated curving fields of the all-over patterns was a difficult matter. In some cases the decorator has attempted to keep her lines running obliquely as the curve swings (figs. 286; 289, *d*); in others she has made a radical change of direction within the area, producing a sort of herringbone effect (fig. 288, *f*). Hatching deserves detailed study, for, as the Gladwins have shown, its different styles have definite classificational value and may well possess genetic significance.[2]

Hatched elements are, in this collection, invariably opposed to solid black ones. The figures balance each other and usually interlock, as in the case of curvilinear treatments (figs. 286; 288, *e*), keys (fig. 288, *a*) and particularly triangles (figs. 288, *b*; 289, *k*).

Keys are both hatched and black. A characteristic feature of the St. Johns Polychrome key, which is never seen in the Pecos Glazes, is the frequent opening, so to speak, of the head, a triangular space being reserved behind the steps (fig. 289, *a*, *e*). In large keys this tendency is carried to the extreme of introducing a second, smaller key, itself containing a little negative triangle (fig. 288, *a*).

As to other elements we have scant information. Triangles, of course, are plentiful, arranged as a rule in series along lines. Rectangles, ordinarily hatched, fill the interspaces between large solid keys (fig. 288, *a*). Black Checkerboarding is seen in but one sherd: it is of the oblique variety (fig. 289, *g*).

[1] See also Hough, 1903, pl. 46, *b*; Gladwin W. and H. S., 1931, pl. XXXVII, *b*; Roberts, 1932, pl. 38, *a*.

[2] 1931, pp. 21 ff.

EXTERIOR DECORATION

The designs applied to the outsides of the St. Johns Polychrome bowls from Forked Lightning are in white lines quite uniformly $^{5}/_{16}$ of an inch in width. Never are they much less than $^{1}/_{4}$ of an inch; the broadest measure nearly $^{1}/_{2}$ inch. The weight of these lines is stressed because it constitutes one of the important differences between St. Johns Polychrome and another ware, Heshotauthla Polychrome, which will be discussed below. Large bold figures are scrawled dashingly about the upper parts of the bowl: series of lines bent at right angles (fig. 288, *e'*), series of zigzags (fig. 290, *a*), interlocking double-ended keys producing a current effect (fig. 288, *d'*), current volutes (part of such an arrangement probably appears in fig. 290, *b*); stepped lines made by offset dabs of the brush are often worked into the patterns (figs. 285, *a'*; 288, *f'*). Very rarely there is incorporated an element in black (fig. 290, *f*).

ST. JOHNS POLYCHROME WITH SUB-GLAZE PAINT

At Forked Lightning ruin there were found nineteen sherds indistinguishable from the material just described save for a slight vitrification of their deep-black paint. In no case is any whole line lustrous; the glazed effect seems to be confined to those parts of lines where the paint was most thickly applied; and even there it is weak and "varnishy." Miss Shepard tested four specimens of this paint microchemically for lead, iron, copper, and manganese. A faint test for lead was obtained from three only after they had been treated with hydrofluoric acid. The fourth sample gave no test for lead. Iron was present in all four. Copper was found in the three-sherd test for this element. Manganese was found in only one sample which also contained the other three elements.

The sub-glaze pottery was evidently contemporaneous with dull-paint St. Johns Polychrome, for it was found with the latter to the bottom of the stratigraphic tests at Forked Lightning (Vol. I, pp. 30-34, footnotes). Whether it is an accidental variant, or whether it is a distinct sub-type which had a separate place of origin is unknown. In either case it is of interest as bearing the earliest known approach to glaze upon any Southwestern red pottery. It should probably be considered the prototype of Heshotauthla and Pinedale Polychrome.

A single sherd is of the same general nature as the above except that the white exterior decoration, instead of being in broad brushwork, is composed of somewhat narrower ($^{1}/_{8}$ to $^{3}/_{16}$ inch) lines forming a current pattern of interlocking double-ended, open-headed keys emphasized by narrow lines of semi-lustrous black paint (fig. 288, *c'*). This specimen seems clearly to foreshadow Heshotauthla Polychrome (see p. 363).

ST. JOHNS POLYCHROME FROM PECOS

Only six fragments of this ware came to light during all the excavations at the main Pecos ruin: four dull-paint and two with faint sub-glaze; the latter emanated from one of the tests in the Plaza of the North Quadrangle (Vol. I, p. 18). Two of the dull-paint specimens are from general digging, the other two were found in Black-

on-white deposits in the Plaza. They differ in no way from the Forked Lightning material, save that one of the dull-paint sherds bears crosshatching (fig. 289, *i*). As Mr. Amsden states in Vol. I (p. 18), the occurrence of these few pieces does not prove that the ware was contemporaneous with Pecos Black-on-white; they may well be bits of treasured heirlooms, or they might have been picked up in ancient times at Forked Lightning. It is also possible that there was a small village of Forked Lightning date somewhere on the Pecos mesa, which was never reached by our excavations; I have, indeed, seen sherds on the surface south of the Mission that lead me to suspect the former presence of an early settlement in that vicinity.

HESHOTAUTHLA POLYCHROME

The above name is suggested for a ware found sparingly in the Black-on-white deposits at Pecos, as well as at Rowe and Dick's ruin, nearby sites of very late Black-on-white times; it does not occur at Forked Lightning, although the single sherd illustrated in figure 288, *c* is apparently a prototype.

Heshotauthla Polychrome is a red pottery which appears in the form of bowls, bowl-and-handle ladles, and presumably ollas. The bowls are characterized by interior decoration in glaze and exterior decoration in matte white often supplemented by glaze. The ware is akin to Pinedale Polychrome, but there seem to be sufficient differences to justify at least a tentative segregation.[1] It centers, apparently, in the Zuñi country. I have no information as to its geographical range. Its date can only be inferred. That it is later than St. Johns Polychrome is proved by its occurrence at Pecos, Dick's ruin, and Rowe, all of which were occupied after Forked Lightning had been abandoned. But it is so similar to St. Johns Polychrome that it may reasonably be considered as directly derived therefrom. If so, the difference in age is probably not great. St. Johns Polychrome was in use during the early part of the 13th Century, thus Heshotauthla Polychrome might well date from the middle to late 1200s. This frankly guesswork dating will of course have to be checked by technological, typological, stratigraphic, and dendrochronological research in the Little Colorado drainage. No Pinedale Polychrome or Four-mile Polychrome has yet come to light in the Pecos Valley.

About forty sherds turned up at the main Pecos ruin. Most of those which could be placed stratigraphically emanated from pure Black-on-white deposits; a few were found in Glaze I refuse. There is thus a possibility that there was an overlap of Heshotauthla Polychrome and Glaze I, but if so it was probably short, for no

[1] Pinedale Polychrome was named and described by Haury (Haury and Hargrave, 1931, pp. 64-68; Haury, 1931, pp. 41, 42): Heshotauthla Polychrome has not as yet been described, but color plates of several bowls may be seen in Fewkes, 1909, pls. IV, 4, 5; V. A large collection of pottery from the type site, which lies about fifteen miles east of Zuñi, is in the Peabody Museum of Harvard. Heshotauthla Polychrome differs from Pinedale Polychrome in having simple, current white exterior designs, instead of more elaborate exterior embellishments which often take the form of repeated units in white-bordered glaze (cf. the description and illustrations in Haury and Hargrave, 1931, pp. 64-68—particularly fig. 19—with the above-mentioned illustrations in Fewkes, 1909).

Glaze I appeared either at Dick's ruin or at Rowe, where Heshotauthla Polychrome had approximately the same frequency as in the Black-on-white beds at Pecos.[1] The following brief description is based on the material from all three sites.

GENERAL CHARACTERISTICS

The ware is three-color: dark glaze and matte white paint on red backgrounds. The best diagnostic is the exterior decoration of bowls in narrow white lines. The interior designs in glaze are simpler than those of St. Johns Polychrome. Only bowls occur at Pecos. The slip is relatively uniform in color, the range being almost exactly the same as in Glaze I Red. The pallid orange-reds of St. Johns Polychrome are not seen.

The slip is usually a heavy coat, easily distinguishable in section to the naked eye. It is smoothly finished, but not polished. Fine crackling is present on almost every piece. A few sherds bear an extremely thin, usually uncrackled slip. These pieces are in other ways (color and fracture of paste, nature of glaze) very similar to Glaze I Red. The glaze lines upon the run of the sherds are generally poorly taken, although there are examples of high luster; the latter are deep black, brownish where thin. The less well vitrified glazes, which, indeed, are often not taken at all save in places where the paint was most thickly applied, have a dull, greeny-black color, which is so characteristic that in the field I several times correctly identified specimens before turning them over and seeing their tell-tale white exterior decoration.

Miss Shepard has supplied the following notes:

"The paste superficially resembles that of St. Johns Polychrome, but appears medium rather than coarse textured and in the half-dozen sherds examined fully oxidized pastes are much more common than in St. Johns Polychrome, as is also an orange paste, 11*c*. Petrographic examination shows that the sherd-tempered paste of most specimens is distinguished by minor inclusions of irregular and distorted aggregates of mica evidently derived from a schist. One sample of glaze was analyzed spectrographically by Dr. E. G. Zies of the Geophysical Laboratory. The spectra of lead and copper are strong. Aluminum, if present, is supressed by the large amount of lead. Manganese, if present, is so in slight amount. Titanium, silver, and zinc are present. Compared with a typical specimen of Glaze I Red tested by the same methods the lead lines are considerably stronger.[2]

BOWL SHAPE

Although we have no sherds sufficiently large to permit even restored drawings, it is obvious that the vessel was of the same general form as the St. Johns Polychrome bowl (fig. 285) with point of greatest diameter well below the rim. Diameters ran from 7 to 11 inches, 8- to 9-inch bowls seeming to have been most common. The *rim* is invariably direct: there is no trace of thickening or thinning, nor even the faint hint of outcurve noticeable in some St. Johns Polychrome rims. The lip is normally rounded; only squarish in the pieces which, as mentioned above, somewhat

[1] I have since found four probably Glaze I Red sherds in the Rowe Collection.

[2] See note on p. 387.

resemble Glaze I Red. A mere suspicion of bevel is occasionally seen (cf. fig. 287, *a*). Vessel walls are from $^{3}/_{16}$ to $^{1}/_{4}$ of an inch thick.

BOWL INTERIOR DECORATION

The pieces are so small that no classification is possible. Bands would appear to have predominated. They are set close below the rim (which bears no ornament).

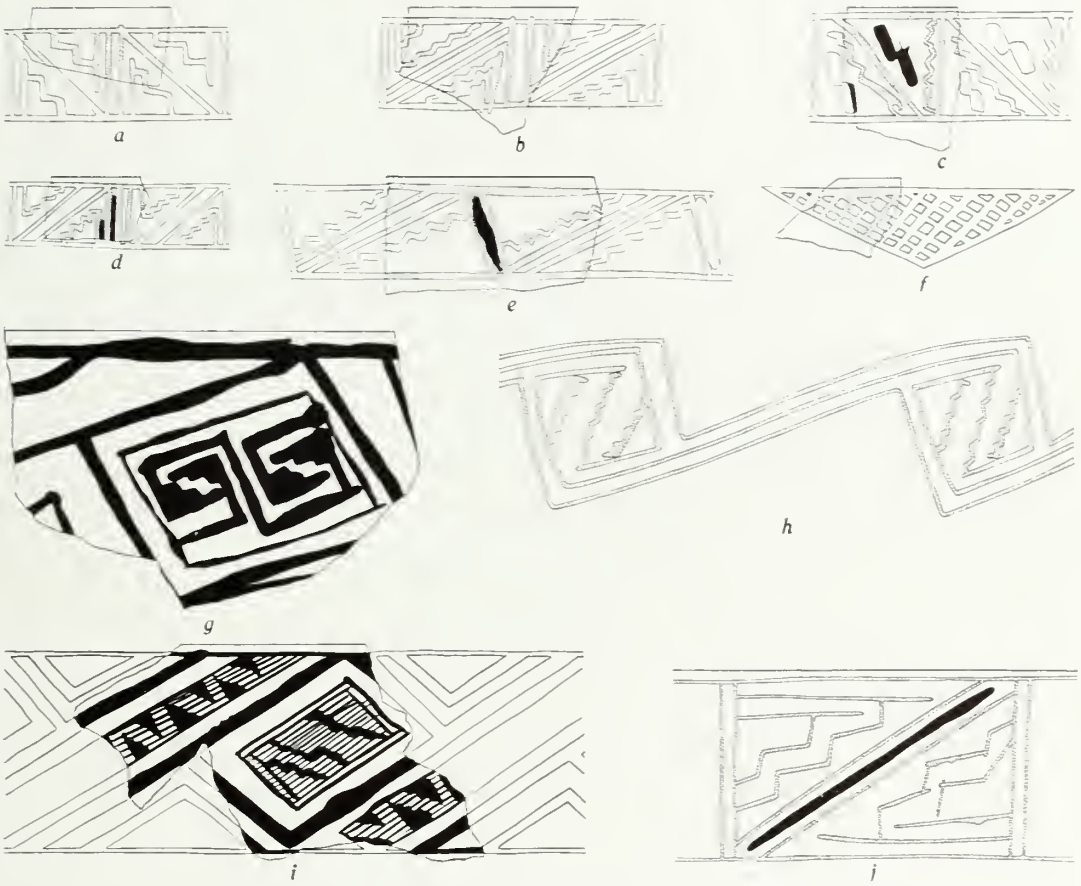


Fig. 291. Heshotauthla Polychrome. *a-f:* Exteriors of bowl sherds. *g, i:* Interiors of bowl sherds. *h, j:* Decorations from exteriors of bowl sherds. Shading represents white paint, black represents glaze. (1/3)

The heavy upper framer of Glaze I is absent, the pattern starting with a single, usually narrow, banding line and terminating similarly below. No case of paneling can be made out. One gains the impression that such current designs as are illustrated in figure 291, *g, i*, were often used. Hatching is certainly much less in evidence than in St. Johns Polychrome, nor is it so regularly opposed by balancing black

fields; it is, on the other hand, more frequent than in Glaze I Red. Hatching lines are 1/16 to 3/32 of an inch in width. There are no curvilinear elements on the sherds collected.

BOWL EXTERIOR DECORATION

The most striking difference between the exterior decoration of Heshotauthla Polychrome and St. Johns Polychrome lies in the width of the white lines. Those of St. Johns are broad (1/4 to 1/2 inch), while the Heshotauthla lines normally measure only about 1/8 of an inch, very seldom over 3/16; there are examples as narrow as 1/16 of an inch. The white paint, too, has a different appearance; it seems to bite better into the slip, is less chalky, and does not wear away so easily. These good qualities are counterbalanced by loss of brilliancy, the Heshotauthla paint being grayer and often finely crackled.

Whole patterns cannot be recovered from the very fragmentary specimens. The commonest arrangement seems, however, to have been a band 1 to 2 inches wide, set close below the rim (fig. 291, *a-e*). It was often paneled, each panel being crossed from one upper corner to the opposite lower corner by an oblique line or lines. The resulting triangular spaces were usually filled by unstalked, open key figures, their steps drawn with a wavy brush-stroke. A bar of glaze was often introduced between the paneling lines (fig. 291, *d*, *e*) or between the oblique lines which subdivide the panel (*j*). Coarse cross-hatching employed to fill triangular areas pendent from a line close under the rim, is observable on several pieces (*f*). In certain instances the glaze slightly overruns the white paint and it is probable that, as in Four-mile Polychrome,[1] it was always applied last. Although there is one sherd bearing a current pattern of interlocking open-headed keys with wavy line steps (fig. 291, *h*), and there are one or two others with parts of what might well have been the same sort of thing, this device is apparently somewhat rarer in the Pecos Valley material than it is upon the bowls from Heshotauthla,[2] which in most other respects our specimens so closely resemble.

CASAS GRANDES POLYCHROME

A single small fragment (fig. 283, *k*) probably, but not certainly, assignable to this ware, was found at Loma Lothrop, a ruin on the west bank of the Arroyo del Pueblo, a half-mile or so northwest or Pecos.

Casas Grandes Polychrome focuses in the Casas Grandes valley of northwestern Chihuahua, with extensions southward into the Babicora country, and westward into the Sierra Madre. It is commonly found in contemporary sites of more northern cultures along the international border in New Mexico, in the El Paso region, and in the southeastern corner of Arizona; it becomes rarer with increasing distance from the focus.[3]

[1] Haury and Hargrave, 1931, p. 35.

[2] Fewkes, 1909, pl. V.

[3] Chihuahua pottery is described in Kidder, 1916, 1924; Carey, 1931. The most recent contributions are by Brand (1935), and Sayles (1936) who discuss distributions and name various types.

Although the age of Casas Grandes Polychrome is not accurately known, it is evident that its life extended well into the Regressive Pueblo period as cross-finds serve to indicate approximate contemporaneity with Gila Polychrome, while it is surely later than Mimbres Black-on-white.[1]

The Loma Lothrop sherd is from the body of an olla. The slip is a warm yellow, the paint is dark brown. Although the piece is two-color, it is very small, and red elements of design might well have been present on other parts of the vessel. The color of slip and paint, as well as the fine lines of the decoration, lead me to believe that it belongs to Brand's Casas Grandes type. Positive identification would, however, be unsafe.

Unrecognized as intrusive at the time of its discovery, the specimen did not come to notice until the sherds from general digging were washed. This is less unfortunate than would have been the case had it turned up unlocated at Pecos, for Loma Lothrop was only occupied for two rather brief periods: first, during early Black-on-white times, apparently contemporaneously with Forked Lightning; and again about the middle of Glaze I (Glaze I Yellow was in full swing, but there was no hint of Glaze II). The piece might have emanated from either of these two horizons, but as most of our work was in the later deposits, and as Casas Grandes Polychrome is of the Regressive Pueblo period, the likelihood is strong that the bit in question actually lay in Glaze I débris. At any rate, it cannot postdate that horizon. Chronological linkage between the Glaze I period at Pecos and the Casas Grandes Polychrome period of Northern Chihuahua may accordingly be evidenced by the sherd in question. But uncertainty as to its exact provenience at Loma Lothrop, and some doubt even as to identification, force one to rate the find as no more than interesting and suggestive. More reliable data emanate from Chihuahua. At Corralitos, Carey took from the upper strata of a rubbish heap five sherds which, from his description, would appear to be Rio Grande Glaze I.[2]

JEDDITO BLACK-ON-YELLOW, SIKYATKI POLYCHROME

Of these two Hopi wares, 165 sherds came to light at Pecos. Mr. L. L. Hargrave, who has kindly examined 140 of them, states that 88 are Jeddito Black-on-yellow or undecorated pieces of Sikyatki Polychrome; and that 52 are surely Sikyatki Polychrome.

Jeddito Black-on-yellow, the earliest of the fine Hopi wares, is characterized by close-grained, cream-colored to yellow paste, apparent lack of temper, and lack of slip; the decoration is in brownish-black paint. It centered in the Hopi region, but was widely disseminated in trade.[3] It was succeeded, or rather developed into, Sikyatki Polychrome, which technologically was very similar; but whose designs were enriched by the addition of red as well as by stippling and by incising through the paint. Sikyatki Polychrome also centered in the Hopi region, and was likewise extensively exported.

[1] Kidder, 1924, p. 103; Cosgrove, 1932, p. 110.
[2] Carey, 1931, Table 5, p. 333.
[3] Hargrave, 1932, p. 29.

The specimens from Pecos will not be studied in the present paper because, according to Mr. Hargrave, they are indistinguishable from the material found at the Hopi ruins, which has been so admirably illustrated by Fewkes and Hough,[1] and which presumably will soon receive descriptive treatment by Mr. Hargrave himself.[2] Our present interest in the two wares lies in their chronological implications.

The general outlines of the Hopi ceramic sequence are clear. The Black-on-white wares of the Developmental and Great Pueblo periods were succeeded, toward the close of the Great Pueblo period, by Jeddito Black-on-orange;[3] Jeddito Black-on-yellow followed, then Sikyatki Polychrome, Awotobi Polychrome, Mishongnovi Polychrome,[4] and finally Hano Polychrome, which is made today.[5] Of these, only Jeddito Black-on-yellow and Sikyatki Polychrome have been collected at Pecos. Neither was ever found in a pure Glaze I deposit. The oldest definitely placeable sherd is a Jeddito Black-on-yellow fragment from Cut 6, Text XII, a layer preponderatingly Glaze I, but containing a strong representation of Glaze II and a little Glaze III.[6] Most of our specimens were from general digging in Glaze III and Glaze IV rubbish, one unmistakable Sikyatki Polychrome piece was in the pure Glaze IV débris in the West Terrace cistern.[7] A few pieces occurred in Glaze V strata (early materials, however, often appeared in late refuse).

Jeddito Black-on-yellow, according to Hargrave, originated about 1300 A.D.[8] This dating is supported by Haury's find of a Jeddito bowl in a burial at Pinedale which also contained two Pinedale Polychrome vessels (1290-1300).[9] How long it persisted before taking on the characters which mark the change to Sikyatki Polychrome is not clear, but Haury implies that it was still in existence as late as 1400: he also implies that Sikyatki Polychrome came into use about 1450.[10] Sikyatki Polychrome probably survived until the early 1600s.

If Jeddito Black-on-yellow indeed originated as early as 1300, its apparent

[1] Fewkes, 1898, Hough, 1903.

[2] The only aberrants in the Pecos collection of Hopi-type herds are a dozen fragments whose surfaces show bright flecks, apparently of iron pyrites. These, Mr. Hargrave writes, are not seen on vessels from the Hopi country. There is also a fragment of a terraced prayermeal bowl, a form not found at the Hopi ruins, according to Mr. Hargrave, until historic times.

[3] Hargrave, 1932.

[4] It is interesting to note that no certainly identifiable Mishongnovi Polychrome has been found at Pecos, although several fragments of the contemporaneous Zuñi Polychrome have come to light (see p. 374).

[5] The name Awatobi Polychrome is tentatively suggested for the degenerate pottery found at Hopi sites occupied during the period of Spanish influence (1636-1680). Bunzel (1929, p. 79) provides an excellent description of this ware, which she calls "Mission" (my substitution of the name Awotobi is in conformance with the system of nomenclature at present in vogue). Mishongnovi Polychrome was made at the Hopi towns during the 19th Century (the ceramics of the 18th Century are still unknown). Hano Polychrome is an archaistic ware. In 1895 Nampeyo, a Tewa woman of Hano, began to imitate the vessels then being recovered by Fewkes from the prehistoric pueblo of Sikyatki. Her product, which was much more beautiful than the typical Hopi pottery of the period, sold readily to tourists and curio dealers; other potters copied her methods and in a few years the new style became dominant (see Bunzel, 1929, p. 80, who calls the ware "Contemporary").

[6] Kidder, M. A. and A. V., 1917, graph, fig. 55.

[7] Kidder, 1924, p. 26.

[8] 1932, p. 29 and chronological chart, pl. VIII.

[9] Haury and Hargrave, 1931, p. 71.

[10] Haury and Hargrave, 1931, p. 42.

absence from Glaze I deposits at Pecos, which were probably laid down during the 14th Century, can only be accounted for by lack of contact with the Hopi country. Our specimens of the ware associated with Glazes II (?) and III are probably late ones, dating probably from the 15th Century. The Sikyatki Polychrome found with Glaze IV serves to date that ware after 1500.

I handled the Hopi pottery found at Pecos very stupidly. I did not realize, when the rubbish-heap investigations of 1915, 1916, and 1920 were being carried on, that two types (Jeddito Black-on-yellow, Sikyatki Polychrome) were involved; my separation of them not having been made until I excavated at the Hopi ruins in 1923. I therefore lumped them both as "Hopi" in my field notes, carefully recording where they occurred and their associations with Pecos Glaze types, but (and this is where the inexcusable blunder was committed) not cataloguing the individual sherds. The result is that I have a large number of Jeddito and Sikyatki material, but almost no information (save that provided by the relatively few specimens found in stratigraphic tests) as to where any given piece was found. The moral is obvious.

SANKAWI BLACK-ON-CREAM

The single surely identifiable specimen from Pecos occurred in a deposit so badly disturbed by graves that stratigraphic assignment was impossible.[1]

The recognition, naming, and description of this ware are due to Mera.[2] With its separation from Biscuit, which it much resembles, I am thoroughly in accord; and I also believe Mera to be correct in considering it transitional between Biscuit and Tewa Polychrome. The influence upon its development which Mera postulates to have been played by Potsuwi'i Incised (see p. 370), is to my mind less certain, although its thinness and the form of the olla-rim both suggest the latter ware.[3] Diagnostic traits are the just-mentioned thinness, lacy black decoration, warm-colored yellowish paste, finely crackled slip. The Pajarito Plateau seems to have been its homeland; Mera states that it is especially common at Sankawi and Tschiregi. He equates it chronologically, on the evidence of surface finds, with his Glaze periods D and E (approximating Pecos Glaze V).

The Pecos piece is from the neck of an olla (fig. 292); the finely crackled slip, which runs just to the edge of the bevelled rim, is a grayed white, decoration is in slightly slaty black paint; the surfaces, within and without are excellently finished; the wall is only 1/8 of an inch thick. All in all, it corresponds extremely closely to Mera's excellent description.

[1] Miss Shepard has called my attention to four sherds from general digging which I originally classified as Biscuit B, but which both she and Dr. Mera consider Sankawi Black-on-cream (three are illustrated in fig. 283, *m-o*). Their decoration, however, conforms exactly to Biscuit B standards. It will, indeed, always be difficult or impossible to draw any sharp dividing line between the two wares, for the one obviously developed very slowly from the other (see remarks on the gradual "yellowing" of Biscuit B—Vol. I, p. 105). One of the above-mentioned four sherds was illustrated in Vol. I (fig. 52, *l*) as exemplifying the latest form of Biscuit B rim.

[2] 1932.

[3] See also Miss Shepard's remarks, p. 497.

Being unplaceable stratigraphically, our specimen has no chronological significance. But its identity with sherds figured by Mera from ruins on the Pajarito Plateau makes it seem likely that it was brought from one of those sites; and if he is correct in believing that some of them existed until after the Conquest—in spite of the fact that pueblos in the Plateau seem to have escaped the careful recording of the Spanish explorers and settlers—its importation may date from the late 16th or early 17th Century. This is approximately the period to which the ware is assignable on stylistic grounds, for it seems certainly to have been developed from Biscuit, which was without much question still being made in the north as late as 1581; and equally certainly to be, in part at least, ancestral to Tewa Polychrome, which probably came into fashion, also in the north, between 1650 and 1680.

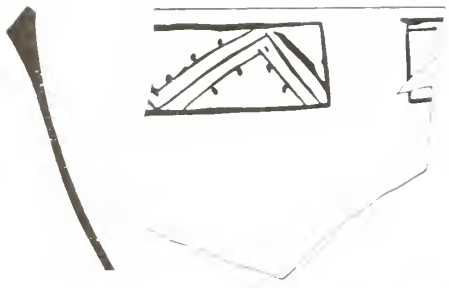


FIG. 12. Sherd of Biscuit ware. Olla neck-sherd. ×½

POTSUWI INCISED

Twenty-two sherds were found at Pecos; all those whose stratigraphic position could be ascertained came from Glaze IV refuse. The rarity of the ware is evidenced by the fact that not a single piece came to light in any one of the many stratigraphic tests.

Potsuwi Incised was so named by Mera.[1] Before that time it had been known as Incised ware. Its diagnostics are: gray color; incised, rectilinear patterns; almost exclusive restriction to ollas. Its range has not yet been delimited with accuracy, but it seems to occur most abundantly at those sites on the Pajarito Plateau and on the Chama drainage which are characterized by a preponderance of Biscuit B. Mera presents good evidence that it postdates Biscuit A and Glaze C—early Glaze III.

[1] Mera, 1935.

Fig. 293. Potsuwi'i Incised (*a-e*) and sherds of other wares showing corrugation (*f-k*). (Width of *b*, 4½ inches)

The Pecos fragments are all small and all from the bodies of ollas. Their occurrence at Pecos serves, of course, chronologically to equate the local Glaze IV deposits with many ruins on the Pajarito plateau and in the Chama country. Datable wood from some of those sites will doubtless eventually come to light, thus accurately fixing the Glaze IV period of Pecos.

Miss Shepard examined eight sherds microscopically. She states:

"Five of the eight specimens are tuff tempered. Their paste is very fine grained. Three of these are exceptionally well smoothed on the interior and the surface has a characteristic scintillation from minute flakes which superficially resemble mica. Microscopic examination, however, shows that they are actually flat flakes of tuff pressed parallel to the surface. This peculiarity is due therefore to the form of the tuff as well as to meticulous smoothing. Four sherds show remnants of a micaceous slip. Three sherds are sand tempered, medium to coarse grained, with a few very coarse grains; they are moderately to heavily tempered. These sherds are readily distinguished from the tuff tempered specimens by paste and surface texture. One has a micaceous slip, and the incised lines are well executed with a round-tipped instrument. The other two are carelessly scratched with a narrow-pointed instrument."

Fig. 294. Gobernador Polychrome. (Height, 7½ inches)

GOBERNADOR POLYCHROME

A small olla (fig. 294) was found near, but not in, a cache of ceremonial material discovered in Room 30, one of the chambers on the west side of the North Quadrangle at Pecos.

Gobernador Polychrome was identified in 1912 by the present writer, who collected a series of sherds at ruins of evidently historic date in Gobernador Canyon, a southern tributary of the San Juan in Rio Arriba County, New Mexico.[1] Subsequent explorations by Morris have shown that this is the home of the style, and have resulted in acquirement of a most interesting series of vessels to be described in a forthcoming paper. The pottery was apparently made by Pueblo refugees who settled in northern New Mexico after the Revolt of 1680, and who seem to have lived there for a relatively brief period. Its diagnostic traits are: extremely hard-fired paste, often black in color; kiln-warped walls with bubble-like excrescences; flushed yellow slip; decoration in matte red and brownish black.

The Pecos specimen is unquestionably of the Gobernador type. It is a small-mouthed olla of the wide-shouldered Hopi shape: orifice, 4 inches; greatest diameter, 10¾; height, 7½. The piece was badly warped in firing; the paste is black; many parts of the surface roughened by fire-bloating. The base is slipped a light, the upper body a darker, red.[2] A black-bordered yellow stripe encircles the shoulder; a narrower one, crossed by vertical black lines and X-marks lies just below the flaring rim. On either side of the upper body is a black-bordered yellow rectangle, vertically barred, each bar bearing a series of small triangles.

The room in which the olla was found was apparently not deserted until toward the end of the occupancy of Pecos, probably not before 1775. If Morris and I are correct in supposing Gobernador Polychrome to have been made in the late 1600's, this specimen must have been nearly a hundred years at Pecos.[3] Its association with ceremonial objects, however, might account for so long a persistence, for we have many instances of extended survivals of cult pottery in the pueblo.[4]

HAWIKUH RECENT GLAZE

Three small olla body sherds, parts of a single vessel, came from general digging at Pecos (fig. 295). As they were suspected of belonging to this ware, they were submitted to F. W. Hodge, who kindly examined them and confirmed the identification.

Hawikuh Recent Glaze, named and described by Hodge,[5] represents a crude

[1] Kidder, 1920.

[2] The colors of this vessel vary so greatly, because of firing clouds, that Ridgway readings are valueless.

[3] Since the above was written, Mr. W. S. Stallings has informed me that tree-ring readings from Gobernador sites indicate that the ruins date from the middle of the 18th Century.

[4] These will be discussed in the volume on the excavations.

[5] 1923, p. 29.

revival of glaze painting that was taking place in the Zuñi country toward the close of Hawikuh's occupancy (the site was abandoned about 1670). Regarding the Pecos sherds, Mr. Hodge writes as follows: "They might easily have come from Hawikuh, where jars of identical type were found in considerable numbers. I regard them as of the early part of the late-glaze period, following the polychrome era which superseded the early glazes, but having its vogue (I refer to the period represented by your sherds) just before the black glaze on red which was made abundantly at the time of the abandonment of Hawikuh a decade before the Rebellion of 1680. It is fairly safe to say that the vessel of which your sherds formed a part was made somewhere about the time of Coronado, although, of course, it may not have found

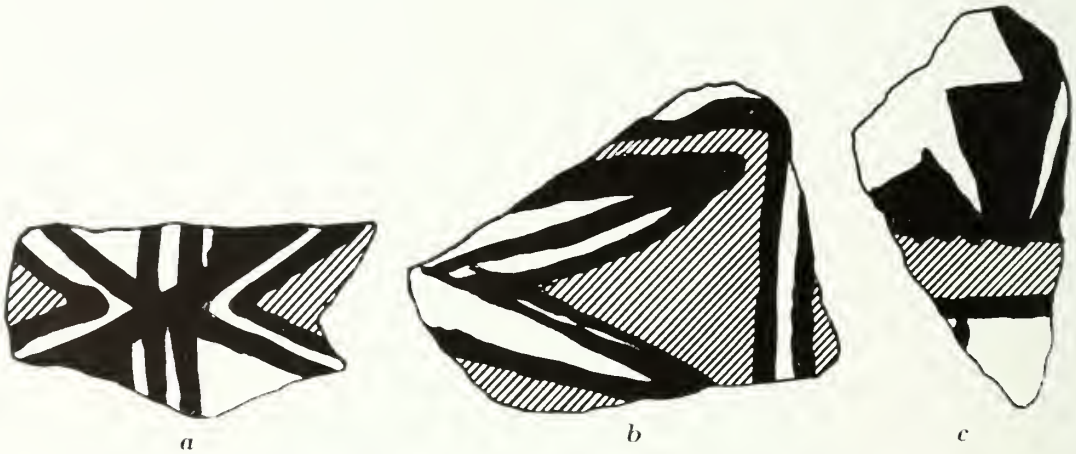


Fig. 295. Hawikuh Recent Glaze. Three sherds from a single vessel. (1/1)

its way to Pecos until a good while after." The style, characterized by greenish glaze and matte red paint, is sufficiently distinctive to permit fairly easy recognition; its almost entire absence from Pecos indicates that little Zuñi pottery was moving thus far eastward in the 16th and 17th Centuries.

ZUÑI POLYCHROME

Considerable parts of two ollas; five small olla sherds; and one end of a rectangular prayermeal bowl came from late deposits in the North Quadrangle.

We know very little regarding Zuñi pottery during the two hundred years between 1680, at about which time Hawikuh was abandoned,[1] and 1879, when

[1] The wares of Hawikuh have been studied intensively by Hodge. That his admirable work should, through no fault of his own, remain unpublished is a severe handicap to the progress of Southwestern archaeology.

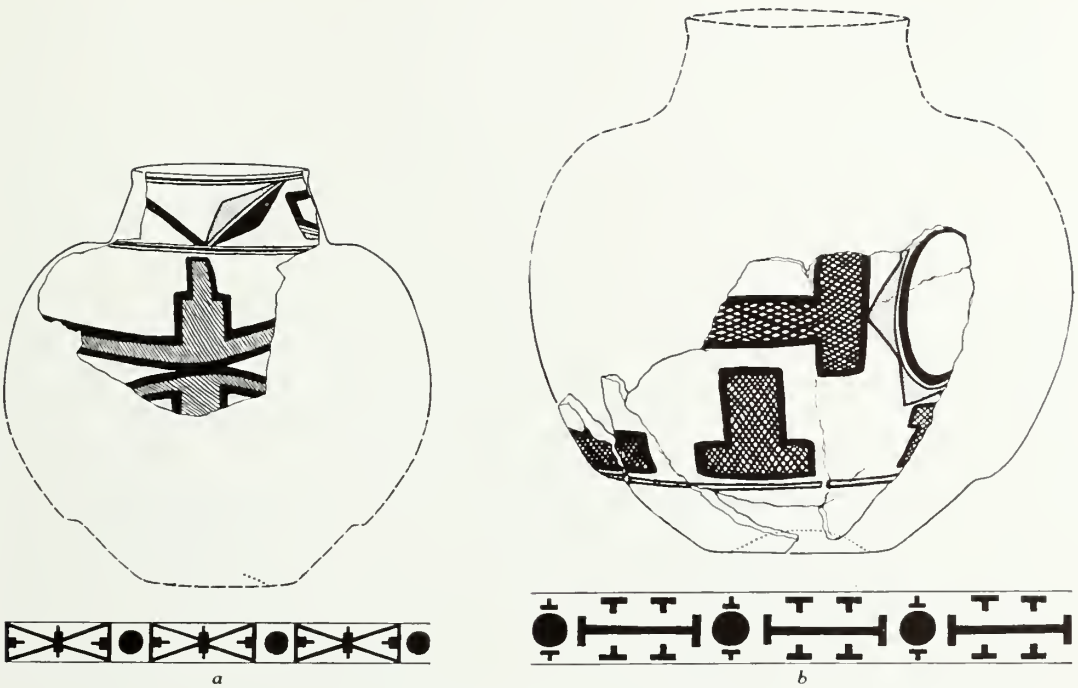


Fig. 296. Zuñi Polychrome; olla fragments. *a:* Brownish paint represented by black; red by stipple. Note very fine hachure in body design. The circular elements and horizontally placed terraces shown in the diagrammatic restoration of the design are indicated by a small sherd from the same olla. *b:* The cross-hachure is red, bordering lines black; the red filling of the triangular edgings of the circular element is represented by stipple. Diagrammatic restoration below. (1/4)

Fig. 297. Zuñi Polychrome. Rain-cloud (*a*) and zoömorphic (*b*) figures from fragment of prayermeal (?) bowl. (1/2)

James Stevenson made his great collection of vessels from Zuñi pueblo.[1] Black glaze on red was in use at the end of the 17th Century; the radically different dull-paint pottery of modern Zuñi (here called Zuñi Polychrome) was in fashion at the close of the 19th Century. The terminal date of Glaze at Zuñi is uncertain; we are equally ignorant regarding the time of origin of Zuñi Polychrome; but a number of the Stevenson pieces are obviously much older than the run of his specimens.[2] How much older they may be is, however, a matter of doubt. Hence the Pecos fragments, which bear extraordinarily close likeness to the more archaic Stevenson jars, are of considerable interest, for none of them can be later than 1838, and some, from the circumstances of their finding, seem to belong to the 18th Century. Thus we have a probable life for this ware of about a century and a half (1780?-1935). Bunzel's excellent analyses of decoration show that, although there have been certain stylistic changes, the Pecos pieces, the Stevenson pottery, and the product of the present-day potters should all be considered parts of a single group.

Because the Zuñi material from Pecos is the oldest which can be assigned a sure maximum date (i.e., 1838), it seems worth while to describe and illustrate the larger pieces.

One of the ollas is represented by sherds from the bottom and lower sides; the other by parts of the upper body and neck. These have permitted the outline restorations given in figure 296, in which will be seen characteristic Zuñi features: small base with distinct mould-mark at the junction of base and body; full, bulging body; sharp break between body and neck; very fine hachure (of red lines in *b*); use of large circles as major elements of design.[3] The ware is heavy ($\frac{5}{16}$ of an inch in *b*; $\frac{1}{4}$ inch in *a*); the interiors are roughened by innumerable tiny rounded protuberances; the exteriors are better finished, but the slip is here and there scarred through to the paste by the horizontal marks of the smoothing stone.[4]

The fragment of prayermeal bowl comprises one vertically rising side and part of the flat bottom. Whether the piece was square or rectangular is problematical. The side is $3\frac{1}{2}$ inches long, $2\frac{3}{8}$ inches high. Dark red paint covers the exterior bottom and runs $\frac{3}{4}$ of an inch up the side; the upper part of the exterior and the whole interior are slipped with creamy white. On the exterior of the one remaining side is the rain-cloud design reproduced in figure 297, *a;* its interior bears two zoömorphic figures (*b*). The flat edge of the rim is painted black.

There is also a fragment which I took to be Mishongnovi Polychrome, but which K. M. Chapman and H. P. Mera, both much better authorities than I, identify as Zuñi Polychrome. It is from a bowl about 4 inches in diameter with direct, rounded

[1] Our present information is admirably summarized by Bunzel, 1929, pp. 74-78; see also Spier, 1917; and Hodge, 1923, 1924. A number of the Stevenson specimens have been published (Stevenson, 1883; Bunzel, 1929).

[2] Bunzel, 1929, pls. V, XX.

[3] See vessel shapes and design frameworks in Bunzel, 1929.

[4] Regarding the olla illustrated in. fig. 296, *b*, Miss Shepard states: "This specimen numbered 69749 contains numerous large pumiceous particles of tuff which ocasionally contain a long prism of hornblende or a crystal of plagioclase. The tuff is very uniform in texture and is distinct from any I have found in the Upper Rio Grande region. Some fragments show slight polarization either from incipient crystallization or devitrification. The other Zuñi specimens from Pecos are sherd-tempered and the black pigment gives a microchemical test for both iron and manganese."

rim (fig. 283, *a*). The cream-colored slip is much crackled. The black paint has a distinctly brownish cast; the red is a very dark purplish shade. The exterior is undecorated save for a narrow festooned device just below the rim. The rim is painted black. Within there is a heavy line about the bottom; above the line are festoons from which rise red figures, apparently flowers and birds; a very narrow line is painted immediately below the slopped-over blackening of the rim.

TSIA POLYCHROME

Pecos produced some seventy-five fragments of a ware obviously similar to pottery made during recent times, and indeed still manufactured, at the pueblo of Tsia, in the Jemez valley. As to the age of the Pecos specimens little can be said except that they are late. Some of them came from deposits evidently laid down toward the very end of the pueblo's existence (i.e., after 1800); none were recorded from the earliest Modern strata. I believe, accordingly, that the years 1750-1838 probably cover the chronological range of the material at our site. The genesis of Tsia Polychrome and the extent of its geographical range remain to be determined.

GENERAL CHARACTERISTICS

The ware, as its name indicates, is polychrome: matte black and red paints upon light backgrounds. It can readily be distinguished from Tewa Polychrome by its harsh feeling slip; by the very much more lavish use of red; and, most important of all, by the fact that the red elements are generally not bordered by black lines as, in Tewa Polychrome, they almost invariably are.

The slip (average color Ridgway 17″″f) is a thin, washy coat, revealing the marks of the swab with which it was applied. It seems never to have been finished with the rubbing stone. Miss Shepard, however, believes that a faint lustre on some specimens is due to use of that tool. This omission, together with much fine crackling and tiny areas of uncovered paste, gives to surfaces the faintly rough feel mentioned above. The black paint tends to rub, sometimes very badly; in color it varies from 13″″k to m (Fuscous to Fuscous Black) to 17″″ (Chaetura Black); exceptionally dark paints are 1″″″m (Sooty Black). The red (Ridgway 8′k) is more permanent; it is even duller and less smooth than the slip.

Miss Shepard notes:

"The black pigment contains iron and manganese, and is magnetic. Viewed megascopically the paste appears fine to medium grained with occasionally a sprinkling of coarse grains, and moderately to heavily tempered. Black angular fragments, many of which have a vitreous luster, are plainly seen with a 10-power lens. The paste usually varies in color from core to margin; cores are 15″″″ (Mouse Gray), 17″″b (Avellaneous), 9″″i (Sorghum Brown) and 9″″b (Light Brownish Drab); margins are 11″ to 15″ (Vinaceous Tawny to Cinnamon.) The tempering material (determined petrographically) is basalt."

VESSEL SHAPES

The material is too fragmentary to provide satisfactory data.

Bowls seem to have resembled the high rimmed Modern painted (Tewa Polychrome) examples (Vol. I, p. 133) in size (sherds indicate diameters up to 17 inches), in relatively great depth, and in rim form (Vol. I, fig. 85; the high, gently recurved rim of the Tsia Polychrome bowls is perhaps, on the average, more widely flaring—see profiles in fig. 298).

Ollas appear to have been of two varieties: 1) Vessels 16 to 18 inches high, taller in relation to their width than any Pecos ollas (fig. 299), with no definite shoulder, and very low, almost vertical, rim with flattish edge; the walls are thick: ¼ to ⅜ of an inch; 2) Vessels of smaller size which appear to have been relatively much less tall (no pieces with rims were recovered, nor enough large body fragments to permit restoration). Walls measure 3/16 of an inch in thickness.

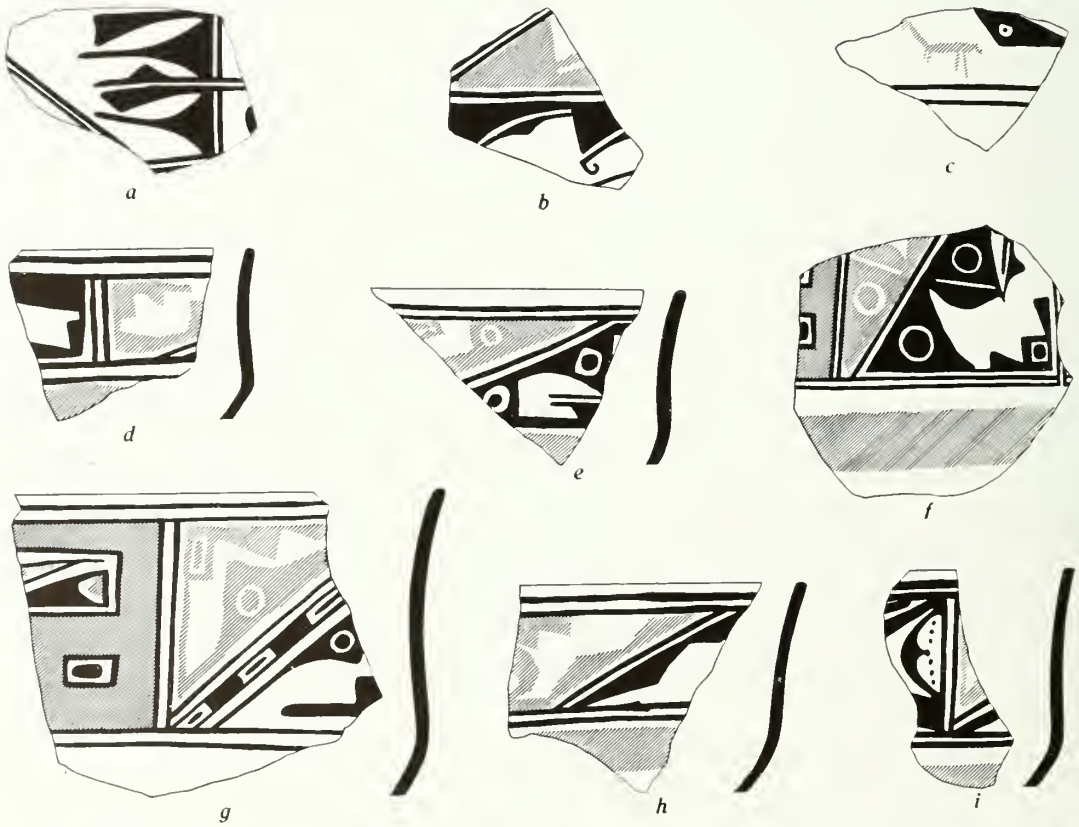


Fig. 298. Tsia Polychrome. *a-c, f:* Fragments from the bodies of ollas. *d, e, g-i:* Exteriors of bowl sherds. (1/3)

GENERAL DECORATIVE FEATURES

Slip extent. *Bowls.* Light slip on exterior of rim from shoulder to outer edge of rim. Red slip in a ½- to 1-inch band below shoulder; a second band, ¼ to 1½ inches wide, often very sloppily applied, upon interior just below edge of rim. Interior and (apparently) exterior bottom unslipped, but paste has been worked with the rubbing stone, as in Modern painted (Tewa Polychrome), to a smooth surface. *Ollas.* Light slip from near bottom to outer edge of rim; red slip in a 1- to 2-inch band margins the white slip below and is also applied to the interior of the rim downward for 1 or 2 inches. Exterior bottom apparently unslipped.

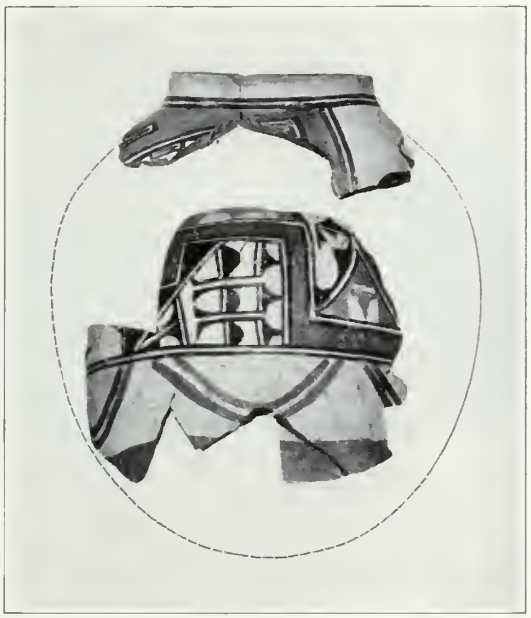


Fig. 299. Tsia Polychrome. Sherds from a large olla. The peculiar tall form has been restored from an apparently closely similar vessel of 19th Century Tsia manufacture collected at Jemez by S. J. Guernsey. (Diam. of orifice, *ca.* 8 inches)

Zones of decoration. *Bowls.* Exterior of the rim only; interior undecorated. Lip often painted black. *Ollas.* Upper two-thirds or so of the exterior. The low, more or less vertical rim is undecorated; the lip is always (?) painted black.

Patterns (fig. 298). Although no analysis can be attempted, it may be noted that the bands, which are regularly painted upon bowl exteriors, have a narrow banding line above and below supplemented by a close-set framing line of the same width. In this they differ from Modern painted (Tewa Polychrome) bands, which ordinarily possess no framing lines (Vol. I, p. 138). The band patterns are sometimes panelled, sometimes not; they are laid out on oblique lines, and often consist of

elaborate key figures in opposed black and red. Olla patterns seem to have been more involved. Characteristic of the decorations are: the above-mentioned unmargined red elements, the very common use of a small reserved circle containing a large dot (fig. 298, *e-g*); curvilinear embellishments. One olla sherd (*c*) bears a tiny red quadruped; the bird and floral patterns of modern Tsia art are lacking. Brushwork is more careful than in Modern painted (Tewa Polychrome); the standard line for bowls is $\frac{3}{32}$ of an inch in width, for ollas $\frac{3}{32}$ to $\frac{1}{8}$ of an inch.

ACOMA POLYCHROME

Six sherds from at least two jars were taken from late refuse. Their association was with Modern painted ware, and the circumstances of their discovery point to an origin not earlier than the latter part of the 18th Century.

The two largest fragments, obviously from the same vessel, are illustrated (fig. 283, *b*, *c*). Designs in brownish-black and deep red are painted on uncrackled, cream-colored slip. The yellowish-white interiors have the same minute rugosities noted on the inside of the Zuñi fragments from Pecos (p. 376).

Although no Acoma pottery older than the pieces collected by James Stevenson in 1875 is known, and although ceramic styles at Acoma seem subject to unusually rapid change,[1] the fragments in question appear to me more like the product of that village than of any other. Mr. Chapman and Dr. Mera, who have been good enough to examine them, are of the same opinion. The judgment of all three of us, however, is based on the "look" and "feel" of the pieces, rather than upon definite technological or artistic criteria. Their positive assignment must therefore await fuller information regarding the technology of Acoma wares.

PANHANDLE PADDLED

One sherd was found in Glaze V refuse on the eastern slope of the Pecos mesa, below the north end of the North Building.

The above name is here coined to designate a dark-colored pottery characteristic of the Panhandle of Texas and parts of eastern Colorado.[2] Diagnostics are: dark, often black, paste; exteriors of vessels textured by blows of what appears to have been a cord-wrapped paddle.

The Pecos specimen (fig. 300, *b*) is from the body of what would seem to have been a small jar-shaped vessel, perhaps 8 inches high. The interior is well smoothed, the exterior marked with overlapping imprints which, although they are not sharply defined, appear, in a plasticene reverse-cast, to have been made by a twisted cord approximately $\frac{1}{8}$ of an inch in diameter, presumably wrapped about a stick or paddle. The sets of marks are roughly parallel to each other; but whether, in relation

[1] Bunzel, 1929, p. 38.

[2] See Renaud, 1931, pp. 88-94; Moorehead, 1931, figs. 37, 38, 49, 50. Its range and its relationship to other wares of the Western Plains remain to be worked out.

to the vessel, they were horizontal, vertical or oblique, cannot be determined. The sherd is variable in thickness—⅛ to nearly ¼ of an inch.

The fragment came from a washed deposit on the extreme edge of the eastern rubbish heap, containing almost exclusively Glaze V pottery. There was, however, an admixture of both earlier and later material. Hence the assignment of the piece in question to Glaze V is not certain; but the probability of its having been brought to the pueblo during that period is enhanced by the fact that stone implements of Western Plains type, which are associated in the Panhandle of Texas with this same sort of pottery, appear at Pecos in greatest quantity during Glaze V. Careful work in eastern New Mexico and the Panhandle, of the sort being done by Studer and by the

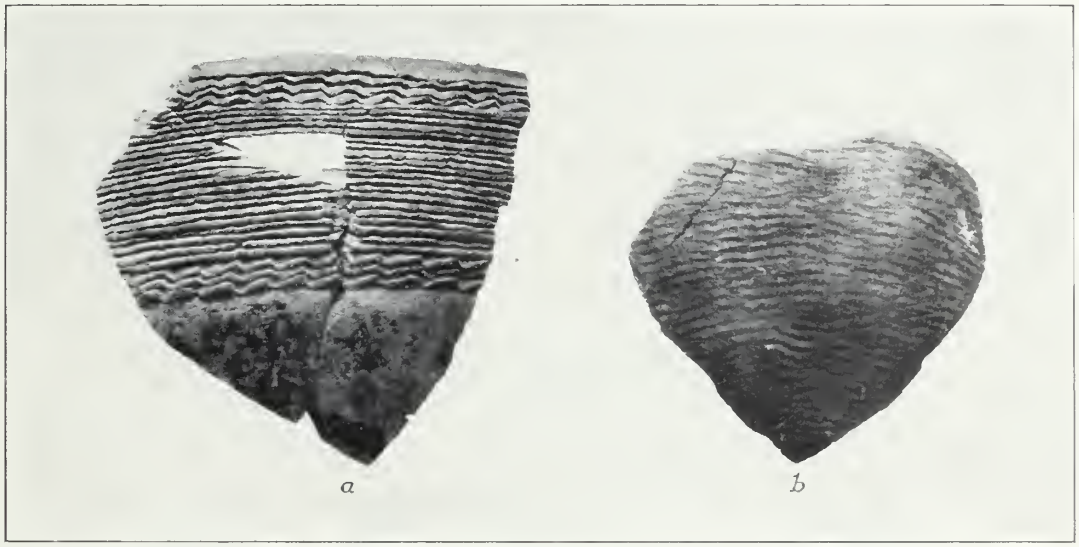


Fig. 300. Tularosa Filletted (*a*) and Panhandle Paddled (*b*) wares. *a:* Bowl exterior. *b:* Sherd from body of a small-mouthed vessel. (Width of *a* at rim, 3½ inches)

Texas Technological College under Holden,[1] should result in accurate cross-dating of the Pueblo periods with the culture phases of the Western Plains. Reliable data can, however, only be secured by excavation; surface finds of Pueblo pottery form unreliable evidence, for, as Holden points out, Pueblo hunters often penetrated the buffalo country, where they may well have camped at abandoned sites. I have seen sherds ranging in age from Black-on-white to Glaze V that were collected by Mr. Leslie Nunn near Amarillo, Texas.

[1] Holden, 1931.

SHERD FROM MEXICO (?)

The pottery of Mexico south of Chihuahua is probably represented by a single sherd from general digging. It is a fragment of the rim of a red bowl (fig. 301). The slip, which closely matches Ridgway's Mahogany Red (7k) has a high, lacquer-like polish often seen upon Mexican wares, but never produced, apparently, in the Southwest. The decoration, too, is of a sort unknown in the Pueblo region. The bowl wall seems to have had gentle vertical undulations, whose valleys, on the interior, were textured, over the original polish, by light horizontal scoring. Over the scoring, in one of the valleys, a scroll has been drawn with some blunt-ended object which has restored the polish. The polished exterior is not decorated.

In addition to its peculiar embellishment and its undulating wall (the latter I can only remember to have seen, among Southwestern wares, in polished red and polished black vessels from Chihuahua), the specimen differs from Southwestern canons in the tapering profile of the rim.

Dr. A. M. Tozzer and Dr. G. C. Vaillant have kindly examined the sherd. Although both believe it to be of Central Mexican origin, neither is able to assign it to any known ceramic group or chronological horizon.

Fig. 301. Interior of bowl sherd from Mexico (?). Horizontal section above, vertical section at right. (1/1)

NOTES

MOULDS

The bases of most Southwestern vessels, except such very small pieces as could be modelled in the hand, were formed in moulds, as a rule the bottoms of old bowls or ollas whose upper parts had been removed. Specimens, forming parts of what were evidently potter's outfits, have come to light in Arizona.[1] From Pecos we have only fragments, mostly of cut-down olla-bottoms. Specially made moulds, of the sort occasionally produced at San Ildefonso,[2] do not appear; but there is evidence that the Pecos occasionally availed themselves of a clever device that seems commonly to have been employed on the Pajarito Plateau. The upper part of an olla was severed by making a horizontal encircling cut about midway between the shoulder and the base of the neck; the edge of the rim was usually also cut away. The resultant

Fig. 302. Pot-mould. Diagrammatic cross-section. The black outer shell is made from the upper wall and lower part of the neck of an olla; the barred element is a sherd or fragment of basket used to close the neck; the shaded filling is hardened ash-paste. (*Ca.* 1/6)

funnel-like piece was inverted, the orifice was plugged from within by a large sherd, an old basket or a piece of matting to support a filling of what seems to have been a mixture of fine ashes and water, which became surprisingly hard on drying (fig. 302). The filling reached the edge of the flaring upper body and could be shaped to any desired degree of concavity. This sort of mould possessed the further advantage of providing a firm, ring-stand base. It was not commonly used at Pecos, for we found only two sherds which could certainly be identified, and a couple of pieces of the ash-mixture linings. Many examples occur in the large ruins of approximately Glaze IV period on the Pajarito Plateau;[3] our two fragments are from Glaze IV ollas. I can find no record of occurrence from earlier or later horizons, or from other areas.[4]

Baskets also served as moulds, commonly at Forked Lightning, rarely at Pecos, where their use was almost entirely discontinued before the close of the Black-on-

[1] Guernsey, 1931, pl. XV, *e*. [2] Guthe, 1925, p. 27. [3] Kidder, 1915, p. 426, pl. XIV.

[4] Since the above was written Mr. E. H. Morris has informed me that he has found this type of mould in deposits of Mesa Verde period (late Great Pueblo) in northwestern New Mexico at the Aztec ruin and at ruins in the La Plata drainage. Corrugated ollas were most commonly employed, but Black-on-white ollas were occasionally cut down.

Fig. 303. Basket-moulded pottery. *a:* Black-on-white sherd from Forked Lightning. The wavy horizontal lines mark the divisions between the successive rings of clay that were pressed into the basket in forming the bowl. *b-d:* Interior, bottom, and side views of basket-moulded Black-on-white bowl from Forked Lightning. The mould was an old basket whose base had been patched, presumably with leather. Width of sherd, 2¾; diameter of bowl, 6 inches.

white period. The Forked Lightning material yields interesting data regarding the shape and weave of the baskets,[1] as well as upon the method of introducing the clay into the form. The vessel was not made by daubing a lining of clay into the basket, as one might suppose would have been the simplest process; but was built up, ring by ring, each successive increment somewhat overlapping the one below and being pressed so tightly down that every detail of the basketry was reproduced and the junctions between the increments obliterated, save for occasional telltale horizontal lines, which show that the rings were ¼ to ½ inch wide (fig. 303, *a*). When the edge of the basket was reached, a free-standing rim was usually added (fig. 303, *d*). The interior of the bowl was carefully smoothed and slipped; slip was sometimes also applied to the exterior of the rim, but never covered the basket-impressions upon the body.

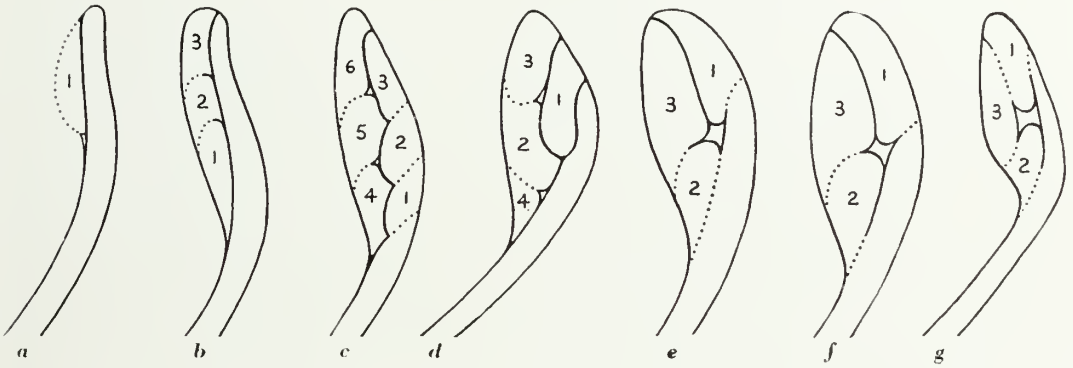


Fig. 304. Sections of Glaze bowl rims showing methods of thickening. The drawings were made from specimens broken in the laboratory for study. Solid lines in the interiors of the sherds represent actual fractures along planes of contact between the elements used in building the rims; dotted lines show inferred planes of contact. The increments are numbered in the probable order of their application to the vessel wall. Note comparatively large open spaces occurring in the body of the rim in *e*, *f*, *g*. Rim *a* is Glaze III; *b*, Glaze IV; *c*-*g*, Glaze V. (1/1)

METHOD OF THICKENING GLAZE BOWL RIMS

Thickened rims, as we have seen, characterize the bowls of Glazes II to V inclusive. In the case of Glaze II we have no information as to how the thickening was accomplished; but it is demonstrable that in Glazes III, IV, and V extra clay, in the form of a long roll or a series of such rolls, was added to the inner surface of the rim. The sectional drawings (fig. 304) make clear how this was done.

The slight increment necessary to bring the Glaze III rim to the desired proportions was applied as a single roll, probably of about the same weight as those used in constructing the wall of the bowl. It was so laid on as to encircle the inner side

[1] Kidder, 1932, p. 296, fig. 245.

of the rim and was then thinned and welded to the wall, presumably by pressure of the fingers. As a rule the Glaze III potter did her welding so thoroughly that no trace of the junction remained. Occasionally, however, the vessel wall was allowed to become too dry, adhesion was not perfect and the added increment, as in the example illustrated in figure 304, *a*, has broken away.

The taller rims of Glaze IV required two or three rolls (fig. 304, *b*). Here again welding was almost always successful and no telltale cracks developed. But the Glaze V rims, having been built up of three to six bulkier rolls (*c-g*), apparently required, because of the greater weight which the vessel wall had to sustain, longer periods of drying during the moulding process. This presumably led to the imperfect cohesion which commonly exists between wall and rolls and, to a less extent, between the rolls themselves. Many specimens can therefore easily be split along the planes of junction by a sharp blow, thus permitting study of the method of their construction. The sections (*c-g*) indicate that although practice varied in detail, the usual custom was to add a single roll to give the wall extra height (the roll numbered 1 in *e*, *f*, and *g*); then two or more rolls were laid within to supply thickening. Weakness in rims so made tended to develop between the vessel wall and the No. 1 roll; failure often took place at this point, the whole added portion coming away and exposing the wall's inner surface, which, in such cases, always shows horizontally parallel marks, probably made by the fingers, which prove that the wall was finished and allowed to become somewhat dry before further work was done. Another weakness was occasionally produced by the presence of a small, tunnel-like space in the centre of the rim, where the rolls did not quite join. This sometimes resulted in swelling of the exterior by expansion of the imprisoned air under the heat of firing; sometimes in causing a long horizontal fissure through which the air escaped; sometimes in throwing off a large flake from the outer surface of the rim. But usually the tunnel apparently did no harm, for it is found in many sherds of bowls which seem not to have been cracked or warped.

COILING IN NON-CULINARY WARES

The so-called "coiling" method of making pottery has been described by Holmes,[1] Morris[2] and others; and, as employed by the modern potters of San Ildefonso, by Guthe.[3] Briefly, it consists of the building of a vessel by the addition to its growing wall of successive ring-like strips of clay; or, and this is true coiling, by laying up spirally a single long strip.[4] This general method was probably used by the prehistoric Pueblos and by their cultural ancestors the Late Basket Makers. I say probably because the junctions between the rings or between the laps of the coil were normally removed from all vessels except cooking pots by scraping and smoothing. Upon the exterior of cooking pots the coils were often allowed to remain; and were manipulated decoratively. But that most, if not all, non-culinary pottery was also built up with strips is strongly indicated both by the clean horizontal fractures

[1] 1886. [2] 1917. [3] 1925, pp. 33-37.

[4] The process is also discussed in the sections on culinary wares, pp. 297-300; 552-561.

which sometimes occur; and, even more clearly, by the presence of unobliterated rings in the interiors of certain pieces with orifices too small to have permitted introduction of the hand. All modern Pueblo pottery is also built with rings; it is therefore to be inferred that the same practice obtained for the decorated wares of Pecos. There is, indeed, some actual evidence to that effect, and the fragments which yield it also provide interesting information as to how the work was done.

The specimens in question are a dozen sherds from vessels with presumably restricted orifices, ranging from Black-on-white to Glaze V. The exteriors are smooth. Upon the interiors the structural increments remain unobliterated. The exposed surface of each increment is about ½ inch wide and as they overlap each other, as shown in figure 293, *f-h*, they must have had an original width of about ¾ of an inch. The method of overlap shows that the strips were applied to the *inside* of the growing vessel wall, as is the custom at San Ildefonso,[1] rather than *outside*, as was the practice in the manufacture of corrugated ware. The sherds being small, one cannot tell whether a continuous strip was coiled upon itself (true coiling) or whether successive strips were added (ring-building). But the presumption is strong, because of the width of the increments and also because they served no decorative purpose, that they were applied, like those of San Ildefonso, as a series of encircling rings.

True coiling was, however, employed in building certain very rare decorated vessels (fig. 293, *i-k*). These were small Black-on-white and early Glaze bowls (the latest seems to be Glaze III) which were made of a single round roll of clay coiled upon itself without overlap from the centre of the base (fig. 293, *k*) to the rim. The interior was smoothed, the exterior either left in its original condition or treated with a slip, and even, occasionally, decorated with glaze. We have sixteen sherds. Their clean fractures along the lines of junction show that the failure to lap the successive turns of the coil constituted a weakness which would have been fatal to larger containers.

[1] See Guthe, 1925, fig. 6.

ADDENDUM

NOTE ON HESHOTAUTHLA POLYCHROME

When the section describing Heshotauthla Polychrome (pp. 363-366) and the table of occurrences of trade wares (pp. 343-344) were being prepared, I was under the impression that all early Glaze bowl sherds with red slip and thin-line decoration found in the Pecos Valley were properly assignable to a single type, although I recognized the fact (p. 364) that a certain number of specimens with thin, uncrackled slip more closely resembled Glaze I Red than did the majority. Technological re-examination of sample sherds, made after Miss Shepard had submitted the brief note included on p. 364, convinces her that more thorough study of all available evidence is necessary before it will be safe definitely to isolate such types as Hesho-

tauthla Polychrome and the apparently transitional Little Colorado-Rio Grande material which Mera calls Los Padillas Polychrome.[1] She states, for example, that the sherd whose glaze was analyzed spectrographically by Dr. Zies (p. 364) belongs to a group of doubtful affinity, its paste bearing superficial resemblance to Little Colorado types, but containing shreds of mica schist which are seemingly not characteristic of those types. The problems regarding the origin of the Rio Grande Glazes raised by these classes of pottery are considered in the concluding section of the present book. It is planned that fuller description of the specimens in question will be published as an appendix to the final volume of the Pecos series.

[1] 1935, p. 31.

PART TWO

THE TECHNOLOGY OF PECOS POTTERY

By Anna O. Shepard

PURPOSE OF THE TECHNOLOGICAL STUDY

The immediate purposes of a ceramic technological investigation are to identify materials and locate their sources, to study the indications of workmanship, and to describe properties by reference to exact, impersonal standards. There are two ultimate aims in the interpretation of technological data. The first is to trace the history of the potter's craft; the second is to recover more accurately and in greater detail than is possible by other methods the evidence which pottery preserves of cultural development, contacts, and influences. In one case, technology opens an almost untouched field; in the other, it offers a new approach to an old problem. The study is necessarily intensive and detailed, but its chief advantage lies in the fact that it is based upon principles and procedures of the exact sciences.

Pottery is of fundamental importance in archaeological research, and the time and energy which have in the past been devoted to ceramic studies have undoubtedly been commensurate with their importance. All features, however, have not been studied with equal thoroughness; attention has been centered upon those characteristics which are most readily recognized and described and whose definition requires no special methods of analysis. Consequently, shape, decoration, and the general appearance of pottery have been carefully recorded, and great strides have been made in defining the geographic and chronologic occurrence of styles. But there has been little progress in the study of composition and the technique of manufacture. This is not surprising, for clay is exceedingly complex and variable both in chemical composition and physical properties, and its qualities are completely changed by firing; furthermore, few identifications can be made by megascopic examination alone.

A comprehensive study generally covers four features of pottery: paste, surface finish, shape, and decoration. This division arises from a consideration of characteristics apart from the processes and methods by which they were produced. When pottery is studied as a craft, a somewhat different approach is necessary; two principal aspects, the technological and the stylistic, become apparent. The technological aspect is concerned with the potter's knowledge of materials and the skill with which she uses them; it involves analysis of clays, tempers, and pigments, study of their sources, combinations, and proportions, observation of the marks of workmanship left in the moulding, shaping, and finishing processes, and study of the indications of firing methods. The stylistic approach is concerned primarily with general appearance and particularly with aesthetic standards and development

as exemplified in shape, finish, color combinations, and decorative design. It is this branch of ceramics which has been emphasized and which, with the usual methods of investigation, has been most fruitful of results. The origin and development of decorative design present a fascinating chapter in culture history. Stylistic features have also furnished the fundamental criteria for classification whenever pottery has been used for culture correlation. The study of technical properties, particularly the composition of the paste, has been less profitable, partly because interpretation of the evidence has been uncertain. This phase of the study demands laboratory facilities and expensive apparatus, in addition to special training and experience not otherwise required by the archaeologist. The value of results should, therefore, be carefully weighed. In what way is our knowledge of pottery and its archaeological significance increased, and what if any new evidence is presented, by such a study?

Potsherds are of great archaeological significance because they reflect subtle changes in skill and taste while remaining comparatively uniform for a given time and place. There are wide variations in the characteristics of pottery made by the people of an extensive territory, and because of this fact it is possible to identify, in a given ceramic group, specimens which were obtained by trade. Fragments of broken vessels, once they are discarded on the refuse heap, remain in stratigraphic position an abundant and imperishable record. This evidence has been studied largely without reference to technological data. The extent and volume of trade have been recognized whenever the exterior features of pottery were distinct. But megascopic methods have failed to show how much exchange there was among people having the same culture traditions. Thus, for example, in the study of Pueblo history it has been possible to gauge the amount of pottery a Rio Grande village obtained from the Little Colorado region, but there was no way of estimating the quantity that came from neighboring settlements within a radius of perhaps fifty miles, since the wares of this area are practically identical in outward appearance. Culture unity must have been preserved by constant contact, but the very fact of standardization renders stylistic studies and megascopic observations valueless as a means of determining the extent of exchange by which this unity was perpetuated, nor do such studies reveal whether one Pueblo produced as much pottery as another, each being virtually independent, or whether certain villages specialized in particular wares. It is in the solution of these problems that the technological data is particularly applicable, for with every difference in geologic formations there are changes in clays, tempers, and even ores used for pigments. Specific identification of such variations of materials and the location of sources will, therefore, prove origin. The possibility of importation of material, as well as of pottery, must always be considered, but the sum of evidence seldom leaves doubt as to the interpretation of technological data. The value of these data is dependent therefore upon accuracy of identification and systematic geologic field work. If such an investigation is thorough and is consistently carried out, it will contribute new evidence to the solution of broader problems as well as increase the certainty of all classification and correlation.

The history of the potter's craft in itself is worthy of thorough study, and obviously the technological aspect must be included if such a study is to be com-

plete and comprehensive. Clay, as few other materials, has tested human skill and knowledge and has offered almost limitless possibilities of refinement in method and new discovery. When primitive woman first found that she could shape wet clay as her need or fancy dictated, and that it became hard and serviceable when subjected to heat, she originated a craft which through the ages has grown into one of the important industries of modern civilization, an industry which for its full development is still enlisting the best efforts of specialists in many branches of science. The archaeologist has studied the beginnings of this industry mainly as an art. But because the use of clay demanded craftsmanship and intelligence or stimulated experimentation, pottery preserves the record of an important phase of man's development. It is the specific field of the ceramic technologists to decipher this record.

The technological approach, though essential for the adequate description and satisfactory understanding of pottery, is not advocated primarily for the purpose of classification; nor are technological features, particularly composition, considered logically satisfactory criteria upon which to base major subdivisions in a system of classification. The systematist endeavors to recognize fundamental similarities and relationships and to group his material accordingly for the sake of convenience and common understanding. If he fails and imposes an artificial system, confusion and profitless effort follow. The archaeologist faces in the classification of pottery a very different problem from that recognized by the biologist, who deals with evidence of descent and organic relationship. The composition, shape, finish, and decoration of a vessel are influenced by available materials, skill and purpose of the potter, her independence or originality, and the customs and traditions of the society of which she is a member; none of these factors resemble organic descent either in the control which they exert or the limits which they define. In view of the purpose of ceramic studies in archaeological research, it seems logical to base major classes upon characteristics which most directly reflect the styles dictated by tradition and which can at the same time be recognized by the field archaeologist and are least subject to errors of personal judgment. Laboratory analysis is essential for specific classification and final description, and there is no reason why the archaeologist should attempt to judge properties which actually require microscopic, chemical or other special laboratory technique for accurate measurement. The major subdivisions should, therefore, be based on the principal surface characteristics, finish, decoration, and form, while paste should be considered primarily for the minor subdivisions which define groups by specific geographic location.

The principal objection that has been raised to such a system of classification is the fact that the archaeologist frequently deals almost entirely with sherds and is, therefore, unable to study form or design, whereas no matter how small the fragment, paste is always represented. This argument is somewhat misleading. As long as non-laboratory identifications of paste are unreliable and not sufficiently specific or definite to be significant, such classification is out of the question. The study of design and form is hampered when only fragmentary material is available; nevertheless, much evidence regarding both features can, by conscientious study, be recovered. Curvature, shape of rim, motives of design, framing lines, and brush

technique have all repeatedly and effectively been used in archaeological studies. Even more important is the fact that finish, color and manipulative technique are unmistakably evidenced on the sherd. Classification has actually been based upon these characteristics in the past because they have proved by experience the most practicable, logical and intelligible. A consideration of the fact that the same paste may be used for a cooking-pot and for a slipped and painted food bowl is sufficient and final proof that a basic ceramic category cannot be defined primarily by paste.

The importance of the technological study is in no way minimized by its inadequacy for serving as a primary basis for a system of classification. Its particular contribution, the possibility which it offers of exact quantitative description, is none the less essential because it represents the final and most detailed phase of ceramic study. The collector or connoisseur frequently asserts that properties can be recognized intuitively though they cannot be described so unmistakably that one unfamiliar with the specimen in question can visualize or understand it. Since pottery is particularly difficult to describe, the same attitude is sometimes expressed by the archaeologist. But it has been demonstrated repeatedly in the history of the sciences that the naming of categories before their characteristics or relationships have been fully investigated has invariably caused error and confusion. The need for specific designation is never so urgent that neglect of adequate description is justified, and it becomes the problem of the technologist to facilitate classification by developing adequate standards of description.

The technological investigation is essentially both humanistic and experimental in its approach. There are many questions which arise in the study of pottery which are apt to be countered by speculation but which can actually be conclusively answered by direct test, and the habit of experimentation prevents needless elaboration of unsound theories and much futile argument. But it is not sufficient simply to analyze; it should also be possible to duplicate characteristics of wares, and a great deal can be learned from the synthetic test. When constant study of every stage in the process of pottery making is necessary, the part which the potter plays can never be overlooked.

The present attempt to formulate and test a procedure for the technological analysis of pottery has been made possible through the inspiration and aid contributed both by students of the exact sciences and by archaeologists.

Many phases of the study and their specific applications were discussed years ago with Wesley Bradfield, who realized the need for such an investigation and gave much thought and study to the subject. Although he did not live to see the materialization of his plan, the present endeavor originated under his influence. Resort to methods of the exact sciences was a natural expression of his uncompromising insistence upon thoroughness and accuracy; with clear vision he regarded the technological study as a most effective instrument for the reconstruction of a phase of culture history.

The opportunity to put theory into practice came as a result of Dr. Kidder's appreciation of scientific method. He has given his entire support that possibilities might be fully tested. At all times he has been patient with long, slow, experimental

processes, and his interest and constructive criticism have been a guide and stimulus in every phase of the work.

Mr. Jesse L. Nusbaum, Director of the Laboratory of Anthropology, has given the project his support.

Since the work has been primarily a problem of adapting principles and procedures of the exact sciences to the study of pottery, it is to specialists in these related fields that acknowledgment is especially due.

My father, Mr. H. Warren Shepard, a research chemist, has given technical advice and assistance, without which the work would hardly have been possible. He has devised methods of analysis, designed apparatus, conducted experiments on organic pigments, and made many of the physical and microchemical tests. His presence in the laboratory has been a constant reminder of the standards and ideals of the scientist.

It has been particularly important in the initial stages of the investigation to compare and test the applicability of as many of the procedures of petrography and chemistry as possible. Dr. Frederick E. Wright, recognizing this fact, suggested study at the Geophysical Laboratory of the Carnegie Institution of Washington. This unparalleled opportunity was made possible, through the interest of President Merriam, Dr. Wright, and Dr. Kidder, by the coöperation of the Carnegie Institution with the Laboratory of Anthropology.

Not only was there afforded, during four months of study, constant opportunity to observe the techniques and apparatus for which the Geophysical Laboratory is outstanding, but Dr. Wright and many of his colleagues also contributed to the solution of specific problems. Dr. Wright directed the study of techniques of measuring optical constants of fine-grained material and experiments to develop a mineral temperature scale applicable in the study of pottery; Dr. E. G. Zies demonstrated the value of spectrographic and other methods for the analysis of small samples; Dr. H. E. Merwin illustrated the use of refractive indices in measuring the lead content of glazes, and Dr. J. W. Greig advised regarding pyrometric practice and checked equipment. Direct aid in a particular undertaking is more easily acknowledged than are the guidance and inspiration which come from association with individuals actuated by scientific ideals. It is for the illustrations of habits and principles of research that appreciation is most deeply felt.

METHODS OF TECHNOLOGICAL ANALYSIS

There is no simple procedure for the technological analysis of prehistoric pottery, nor should the chemist or ceramist alone be expected to determine all that can be learned about it. The primitive potter's methods and the consequent properties of her wares are, in fact, so totally foreign to the experience of the commercial ceramist that he often does not visualize conditions nor appreciate the questions they raise. But petrography, chemistry and ceramics each contribute valuable methods, the neglect of any one of which leaves the investigation incomplete, while

the archaeologist brings to the study the essential knowledge of occurrences and the recognition of problems. Various procedures of the exact sciences must, therefore, be coördinated and adapted to the specific purpose of the archaeologist. It is evident that a complete and final outline for technological analysis cannot be given now nor at any future time, for as progress is made in correlated sciences the ceramic technologist must be ready to adapt and expand his methods accordingly. Then, too, new and different archaeological problems will continue to arise.

The present discussion is not given with any idea of laying down procedures which must invariably be followed or of treating fully the entire scope of the subject, but rather in the hope that it may be suggestive of the varied aspects and possibilities of the work, and that it may bring out the importance of thoroughness and exactitude. Certain of the tests outlined are fundamental and essential; they will apply in the study of any group of primitive pottery whatever its provenience, while other methods and problems considered are related specifically to the Southwestern field. The results of the Pecos study will serve to illustrate the significance of the technological data, but it must be remembered that the interest and value of the data are directly related to the state of ceramic advancement represented; the more highly specialized the technique and the greater the number of materials used the more there is for the ceramic technologist to learn.

Study of Body and Slip Clays

Clay is exceedingly difficult to analyze and describe because it is very fine-grained, its composition and properties are complex and highly variable and when heated its characteristics are completely changed. The study of clay in pottery is further complicated by unknown firing conditions. How is one to know, for example, when comparing two fragments of pottery whether differences in color and hardness result from the use of distinct kinds of clay or from different firing treatment? Even the texture and the finer mineral inclusions of pottery paste are not necessarily those of the clay, for the potter frequently added non-plastic material to counteract shrinkage and it may be impossible to distinguish the finer part of this artificially included mineral matter from that which occurred naturally in the clay. One cannot always be certain, consequently, whether the clay of a paste was originally sandy or relatively fine-textured. It is not surprising therefore that the archaeologist should consider clay a single, even though variable, substance and treat it in the most general terms.

It is nevertheless important for the ceramic technologist to understand the properties of clay and to be able to distinguish the various types. In the first place there is the specific problem of description and classification; clay, the basic ceramic material, can hardly be ignored by the systematist, yet of the statements regarding pottery clay which have appeared in archaeological literature few indeed are definitive. In the second place we should be able to distinguish the characteristics of pottery which reveal method from those which are the result of the quality of the material used and for this purpose a knowledge of clay is indispensable. In the third place the accurate identification of clay and the location of its source may give

valuable evidence of the provenience of pottery. It is, of course, much simpler to identify and locate the source of the mineral inclusions in the paste. But if tempering material comes from a formation distant from the site where the pottery was found, the question arises whether the material or the vessels were imported. If it can be proven that both clay and temper came from the same immediate locality, the probability that the vessels, rather than the raw materials, were imported is greatly strengthened. Finally there are many questions of general interest and significance which can be answered only when the properties of clay are understood. To what extent has the quality of available clays influenced the progress of the potter's craft? What does the number of distinct kinds of clay used reveal as to the versatility of potters of different periods? How much judgment is shown in the kind of clay selected for particular wares? We have hardly stopped to consider these questions principally because we know so little about clay.

A brief review of familiar facts relating to the origin and properties of clays may serve to illustrate the possibilities of differentiating distinct kinds of clay and of explaining common characteristics of the paste.[1]

Clay is usually recognized as a very fine, compact, earthy material which in its purer state has a soapy feel and when moist a characteristic odor. It has played an important role in man's cultural development, principally because the plasticity it acquires when wet makes it an ideal material for modeling, and the changes produced by heat give it strength, hardness and some degree of impenetrability. The great variability in color, composition and texture of clay is explained by the many modes of its formation. All clays are originally derived from the decomposition of igneous rock. Weathering is a universal cause of rock decomposition and formation of clay in the outer zone of the earth's crust. At far greater depths rocks are altered through the action of hot vapors and gases given off by molton rock magma. The kaolin deposits of Cornwall are examples of this kind of clay formation. Deposits of this type are often extensive because the products of alteration are not removed by erosion as they frequently are when rocks at the earth's surface are disintegrated and decomposed. In the outer layer of the earth's crust subject to weathering, mechanical, chemical, and even biological forces are active agencies in rock alteration. Daily and seasonal changes in temperature cause rocks to expand and contract, with resultant fracturing and gradual disintegration. The minerals thus exposed to the chemical action of air and water are slowly attacked, bases are removed in solution and new and more stable compounds are formed by the addition of oxygen, carbon dioxide and water.

Acid igneous rocks high in feldspar, such as granite and pegmatite, contribute chiefly to the formation of clay, but it is also formed from the decomposition of basic igneous rocks. The alteration of granite illustrates the changes which occur

[1]For fuller discussion and reference the following works are suggested:

General: Ries, 1927; Searle, 1929-1930; Wilson, 1927.
Formation of clay: Leith and Mead, 1915.
Effect of heat on clay: Bleininger, 1911.
Origin and properties of the clay minerals: Ross and Kerr, 1931, 1931a; Ross and Shannon, 1926.

when rock is weathered. The feldspars, which constitute on an average 52% of the minerals of granite, become hydrated and lose their alkali as carbonate or bicarbonate, together with some silica. The hydrated aluminum silicate which remains is a relatively stable compound and forms the basic material of clays. Iron from the decomposition of biotite, hornblende, and other ferromagnesian minerals, forms hematite or limonite which colors the clay. The calcium and magnesium liberated from various minerals unite with carbon dioxide and are deposited as limestone and dolomite. Soda is carried off in solution eventually reaching the sea. Quartz is the most stable mineral and largely remains as grit or sand, the relatively small amount which is leeched out by solution being redeposited as chert. The end products of alteration are therefore clay, quartz sand, iron oxides, calcite, dolomite and the salt of sea water. Clay is the proponderant product.

Two general types of surface clay are recognized, residual and transported or sedimentary. Residual clays occur *in situ*, where alteration took place, while the sedimentary clays have been transported and redeposited by water, wind, or glaciers. In beds of residual clay, a gradual transition from clay down through disintegrating rock to original unaltered rock may be recognized, while transported clays bear no relation to the underlying rock and, unlike the residual clays, are stratified. Water is the chief agency in the transportation of clays which are reworked and sorted by its action, the fineness of sedimentary clays depending upon the velocity of the current. Residual clays usually contain grit and fragments of unaltered rock.

Sedimentary clays are classified according to the conditions under which they were formed as marine, estuarine, lake, river terrace, glacial, and aeolian. Marine clays, which are deposited some distance from the shore, usually form extensive beds, but as material from more than one drainage contributed to their formation, their composition varies in different parts of the deposit. Lake clays are found in relatively shallow, basin shaped beds. Terrace clays formed along river benches in the flood season are frequently sandy. Glacial clays, not having been subject to the sorting action of water, are often gritty and full of stone. Aeolian clays are characteristic of extreme arid conditions.

Changes may be produced in clays after their formation. They may be consolidated by mechanical forces, such as tilting, folding, and faulting, and so altered to shale. Shales which have been formed principally by pressure can be ground and plasticity again developed, but if subjected to heat as well as mechanical force, they are converted to slate and are no longer of value to the potter. Clays may also be affected by chemical forces. Contact with air oxidizes the iron in clay, changing its color from gray to yellow or brown. This effect is particularly noticeable in the outer layers of a deposit. Iron may be carried in by percolating water, and substances may be removed in solution, as, for example, lime by water charged with carbon dioxide and iron by water carrying carbon dioxide and organic acids.

The basic substance of clay is hydrated aluminum silicate, but the ratio of alumina to silca, as well as the number of molecules of water of crystallization, is variable, and consequently there are a number of distinct clay minerals. These clay minerals are very difficult to identify because their crystals are exceedingly minute and rarely found in a pure state. Some idea of the confusion which has existed in

the classification of clay can be gained from the fact that in 1914 sixty-one names had been applied to hydrous aluminum silicates and many of these varieties were not properly established. Recent studies by Ross and Kerr of chemical composition, optical properties, x-ray defraction patterns and dehydration curves have greatly clarified the properties and relationships of the clay minerals and reduced the number of established varieties.[1] These writers classify the clay minerals in four groups, two of which—the kaolinite and the beidellite-montmorillonite—they have described. Kaolinite, which forms minute vermicular or thin platy crystals, is the principal clay mineral in residual white-burning clays and is also found in sedimentary beds where it has been redeposited from the erosion of primary deposits. It is commonly formed by the profound weathering of feldspathic rock. Since residual white-burning clays are of mixed or variable composition they are properly called kaolins and the term kaolinite restricted to the mineral whose properties and composition have been specifically defined. The word *kaolin* is derived from the Chinese *kao lin*, meaning *high hill*, the name of a locality where clay was obtained for the manufacture of porcelain. The beidellite-montmorillonite clay minerals occur in many soils and marine shales. Montmorillonite is the characteristic mineral of bentonite, a clayey material formed from the decomposition of volcanic glass. Bentonite is highly adsorbent and is used commercially as a decolorizer. Deposits of this material are common in some parts of the Southwest, and when used as body clay or slip by primitive potters, its distinct optical properties distinguish it from a kaolinite-bearing clay.

Many mineral impurities occur in clay, only the commonest of which need be mentioned. Quartz is the most ubiquitous and varies in amount within wide limits. In residual clays it is a remnant from the disintegration of the parent rock; and in sedimentary clays it has frequently been introduced from various sources by the transporting agency. Quartz reduces the plasticity, shrinkage and strength of clay. The micas, muscovite, sericite and less frequently biotite, are present in many clays. Very finely ground mica has been used to substantiate the theory that platy structure is an important cause of plasticity but coarse mica reduces plasticity and its fusion point is above the temperature range of primitive firing. Iron compounds are largely responsible for the red color of burned clay. Hydrated iron oxide (limonite) occurs in yellow clay, ferric oxide (hematite) in red clays and ferrosoferric compounds in certain bluish clays. Pyrite (iron sulphide) and siderite (iron carbonate) are also present in some clays. Ferric oxide acts as a gradual flux while ferrous oxide acts as a violent flux combining with silica to form ferrous silicate, the slag of the open hearth furnace.

Other minerals occur in clays in small quantities and may affect their firing behavior. In attempting to explain the properties of a fired clay, therefore, one must remember that a number of materials and a variety of factors have influenced the result.

The effect of heat on clay is clearly summarized in the following statements by Hewett Wilson:[2] "From the chemical standpoint, dry clay consists of a large variety

[1] 1931, pp. 55-65 [2] 1927, p. 142

of silicates in various conditions and stages of combination. When clay is heated, some of the compounds are broken down, water vapor and other gases are evolved, while oxygen is taken into combination. Finally, when portions of the mass attain the fused condition, a new variety of complex alkali, calcium, magnesium, iron, and aluminum silicates are formed."

Three periods of firing are recognized, dehydration, oxidation, and vitrification. When clays are heated the mechanically combined water, that which remains after air drying but is not a constituent part of the clay substance, is first driven off. During this stage of dehydration, generally called water smoking in commercial ceramic practice, a low temperature should be maintained, otherwise steam may form more rapidly than it can escape through the pores of the vessel and the walls will be shattered by pressure. The primitive potter, who uses a direct fire and attains maximum temperature in a very short time, often avoids the risks of too rapid dehydration by first heating her pots around a bonfire. Mechanical dehydration takes place at temperatures between 20° and 150° C. and from 150° to 600° C. the chemically combined water of the clay substance is removed. The rate of dehydration is influenced by the texture of the clay, being slower for a dense compact clay than for a sandy open-textured one. The temperature at which the plasticity of the clay is lost varies from 400° to 800° C. depending upon the type of clay.

The oxidation period extends from a temperature of 350° to 950° C. It therefore overlaps the dehydration period, but while dehydration requires heat alone, oxygen as well as heat is necessary for oxidation. During the oxidation period any organic matter present in the clay is broken down and the carbon thus liberated unites with oxygen passing off as carbon dioxide gas. The effect of oxidation is seen in color changes; light and dark gray clays become whitish, buff or red, as carbonaceous material is burned out and iron is brought to its highest state of oxidation. The color of fired clay is, therefore, affected by firing atmosphere as well as by temperature and chemical composition. The same clay, for instance, may fire either buff or gray at a given temperature depending upon whether there is free circulation of air, and examples of red paste found among sherds which are ordinarily gray do not necessarily indicate a higher firing temperature.[1] The rapidity with which carbon

[1]A comparison of the original color of a paste with that produced after it is fired in an oxidizing atmosphere shows whether or not the clay was fully oxidized by the original firing for the temperature maintained in refiring, but sweeping conclusions regarding the original firing atmosphere are not justified by this test, unless the character of the raw clay and the time and temperature of the original firing are known. The condition of iron in clays differs and the amount of carbonaceous material they contain is variable, moreover, even with the same atmosphere, results obtained with short firing at low temperatures cannot be expected to be comparable with those obtained with longer firing at higher temperatures. With primitive methods the character of the firing atmosphere—the volume and proportion of the reducing gases, carbon monoxide and hydrocarbons—will necessarily vary during different stages of firing and from one firing to the next; it may be reducing in effect at the start and oxidizing at the close or more strongly oxidizing at one time than another. A difference in color between core and surface zones of a paste shows that a given atmosphere and temperature were not maintained long enough to complete the change but here also caution should be observed in the interpretation of observations; for example, a gray core with red margins would ordinarily be considered the result of partial oxidation of a gray paste but tests have shown that certain red clays fired in an oxidizing atmosphere develop a gray core at low temperatures and with short firing. The oxidation of carbonaceous

is removed during firing depends upon its condition and upon the density of the clay. Vegetable matter, common in surface clays, is generally readily oxidized. Bituminous matter, more frequently found in shales, evolves volatile hydrocarbons, increasing the difficulty of firing; if the temperature is too high the pressure of gas may shatter the vessel wall or the gas may flash into flame, raising the temperature too rapidly. If the clay is dense and oxygen does not penetrate fast enough to supply the carbon, it will remain unburned and form a black core; such unoxidized central streaks are common in many types of Pueblo pottery because they were given a short firing at relatively low temperatures and with insufficient draft. A high percentage of carbon may indirectly cause the paste to fuse and bloat. Ferrous oxide, a violent flux, is not oxidized until all carbon is removed, and if the temperature becomes high enough to vitrify the paste, carbon will be trapped and carbon dioxide or monoxide, which continues to form but cannot escape, will cause bloating. This combination of conditions may explain vitrification and bloating of some types of Pueblo pottery.

After volatile matter is removed during the dehydration and oxidation periods and before vitrification takes place, the fired clay body attains maximum porosity. Vitrification, the melting and reacting of certain components of the clay, increases the strength and reduces the porosity of pottery. Vitrification commences before the appearance of the pottery gives any evidence of the change. In the incipient stage just sufficient sintering takes place to cement the clay particles. The ware will still have an earthen fracture and a porosity of 15% or more. As the temperature is raised, more of the material of the body is drawn into the melt, pores are filled and porosity is reduced to 1%. With still higher temperatures, complete fusion and melting occur and the body no longer stands its own weight. Vitrification is affected by a number of factors, most important of which are the silica-alumina ratio, fluxing impurities, the texture and grain size of the body, homogeneity of the mass, and the conditions of firing. Very high temperatures are required to melt pure aluminum silicate, but various impurities, such as alkalies, ferrous iron and lime, reduce the fusion point. The vitrification of primitive pottery is, therefore, explained by these fluxing impurities rather than by excessively high temperatures.

With these general facts in mind we may ask how much the ceramic technologist can learn of the origin and properties of clay in pottery and what tests can be applied to distinguish clays and identify their sources. At the outset the importance of preserving all samples of potters' clay found in the course of excavation cannot be overemphasized. A survey should also be made of the clay resources in the immediate area of the site being worked. By studying the thermal behavior of these

material in clay has been used in the present study as a simple means of comparing the relative oxidizing effect of a firing. A short cylinder moulded from a standard mixture of clay and lampblack is fired with the pottery. When the cylinder is cut in half the width of the zone from which the lampblack has been burned out furnishes a basis for comparing total atmospheric effect of the firing. This test has proved useful not only in comparing modern Pueblo firings but also in experimental work with different methods of firing. We have little reason to doubt that there were consistent and significant changes in character of firing atmosphere during Pueblo history and some intelligent control exercised to produce the various specialized wares. These remarks are intended only to emphasize the factors which must be considered before we can prove what changes did take place.

raw clays and their properties when fired, comparisons can be made with the clay of vessels and original sources thus often located. Such a study offers the most practical means of ascertaining the geological classification and position of the clays used in pottery as well as their original properties.

In the study of either raw or fired clays, many different methods may be employed, including petrographic and chemical analysis, the determination of physical properties, thermal behavior, x-ray defraction patterns and ultramicroscopic examination. No single method can be expected to give all of the information desired, and the problem becomes that of combining methods so that distinct clays can be recognized and defined by a number of characteristics, in spite of the difficulties arising from impurity of material and highly variable and uncertain firing. The study of optical and physical properties together with thermal behavior has been most useful in the present investigation. Chemical analysis may be justified in specific cases. The other methods have not been applied in archaeological studies, and the data obtained may not warrant the expense involved.

The optical properties of clay (color in transmitted and reflected light, refractive indices and birefringence) are studied with the petrographic microscope.[1] Clay particles are so minute that measurements of optic sign and extinction angle can seldom be made, and in fired clays, particularly, aggregates rather than individual particles must be studied.[2] The color of the paste is affected by firing temperature and atmosphere, and as these may differ considerably even within a type, the observation is of limited value unless specimens are refired to bring them to a comparable state of oxidation and give them the same heat treatment. Refractive indices and birefringence have been found the most significant of the optical properties. In determining refractive indices, it is necessary to let the powder stand in the liquid long enough for the part measured to become saturated; otherwise the refractive index of clay and air is recorded and the value will be low. Experimentation is the best guide in deciding how long the particles should be immersed, for the time required as well as the difference in values will depend to a considerable extent upon the character of the clay. Data on optic properties of the principal clay minerals are given by Ross and Kerr.[3] These determinations are for the pure clay minerals, all samples having been carefully selected and tested. The same purity of material cannot be expected in pottery; moreover, optic properties are changed upon firing. Birefringence will be destroyed if the firing temperature has been high enough to break down the crystalline structure of the clay or to dissociate the aluminum silicate, but for many pottery types this temperature was not reached. The strength of birefringence is one of the most reliable means of differentiating montmorillonite from kaolinite. The refractive indices of these two clay minerals

[1] Training in the principles of petrographic technique is required for this phase of the investigation. The purpose of this discussion is merely to point out certain applications of petrography to the archaeologists' problem.

[2] Occasionally platy particles of clay are rearranged when a slip is polished and aggregates of similarly oriented particles are forced into a position parallel with the surface. When this condition is found an approximate determination of extinction angle can be made.

[3] 1931, 1931a.

are also widely separated, those of montmorillonite being lower. But upon firing, the values undergo repeated change depending upon the temperature attained. Preliminary experiments have shown that in general the indices of the kaolins and red-burning alluvial clays increase consistently, the change being relatively slight in the temperature range of the primitive potter, but the indices of bentonite, which is composed largely of montmorillonite, undergo sharply defined increases and decreases so that at certain temperatures, values may be the same as those of kaolinite, while at other temperatures they may be as low as when the clay is in the raw state. Therefore, low refractive indices (1.500 to 1.530) in a paste are evidence of the presence of montmorillonite or related clay minerals, but since the values of these may reach those of kaolinite at certain temperatures, refractive indices alone will not invariably reveal the presence of montmorillonite. Although this data may seem involved and detailed, in the Pecos investigation it has proven useful for distinguishing clays and locating their sources, and the results of this study will illustrate its application.

A comparison of physical properties of pastes cannot differentiate clays unless the firing conditions have been identical. Thus red-, buff-, and white-burning clays might all be medium gray if burned with a smoky fire at the Indian's comparatively low temperatures, but if the sherds are refired to critical temperatures the significant differences will develop. Exact temperature control is of course essential for this phase of the investigation. Heating in a blow pipe flame is of little value, for although the sherd may be oxidized the heat treatment is too uncertain and variable to furnish a sound basis for comparison. The color of the clay when oxidized at temperatures within the potter's range can be brought out by heating sherds at 850° C. for half an hour. More striking color differences are usually developed at higher temperatures, 1000° to 1200° C. for example. It will sometimes be found that of two neutral gray sherds one will burn red and the other buff, which fact definitely establishes a difference in the clays.

The refractoriness of clay, determined by the degree of heat which it will stand without melting and deforming, is a significant and important property. If pottery is refired to critical temperatures, its hardness and porosity will give some indication of its relative refractoriness, for both hardness and density increase with the progress of vitrification. But the refractoriness of a pottery paste is influenced by the kind, grain size and amount of tempering material which it contains as well as by the refractoriness of the clay base. In order therefore to compare the clay base of different specimens the temper must either be the same or the error which it introduces must be determined experimentally. Tempering material may affect the fusion point of the paste in two ways: it may raise it by coarsening the texture, so that it is loose and open and clay particles lacking close contact do not readily sinter and bind; or it may reduce it if the tempering material itself has a low melting point. The effect of easily fusible temper is illustrated in the Pecos study; two gray pastes, one untempered and the other tuff-tempered, became upon firing to 1200° C. a brick red and were discovered to be non-refractory, but porosity tests proved that the tuff-tempered specimens were more completely fused than the untempered ones. Upon heating samples of tuff it was found that the edges of flakes were softened

and rounded at 1000° C. and distinctly melted at 1200° C. So the presence of this easily fusible temper had promoted vitrification of the paste, and the clay of the untempered and tuff-tempered sherds could not be compared in this way. The extent to which temper affects vitrification can be determined experimentally for particular clays. Test pieces can be made, keeping all factors except temper constant, then by varying successively kind, grain size and amount of temper, the effect upon porosity produced by each can be measured and compared with the differences recorded for pastes. For example, with a red-burning alluvial clay fired to 950° C. a reduction in amount of sand temper from 25 to 10% reduced porosity 6%, and when the grain size of the sand was changed from 50% coarse—50% medium to 100% fine the porosity was reduced 0.8%. Therefore, even though tempering materials differ, if it is ascertained that the difference in porosity of the refired pastes is considerably greater than the possible variation produced by temper, a difference in the refractoriness of the clays is established.

Color, density and refractoriness form the basis of the ceramist's classification of clay. This system might be simplified and adapted to the archaeologist's requirements, for it offers a means of designating and comparing the actual properties of the clay used in pottery irrespective of differences resulting from the varied and uncertain methods of the potter. Three color divisions may be used and the range of each defined by the Ridgway standards (see pp. 430-432) as follows:

White-burning—Colors nearer white than Ridgway's *f* tones.
Buff-burning—All *f* tones, *d* tones from 9 to 19, *b* from 15 to 19.
Red-burning—All colors darker than *b*.[1]

Sherds must be refired in an oxidizing atmosphere to definite temperatures to define color. In the present investigation sherds were heated at 850° C. for half an hour and also fired to 1200° C. Intermediate temperatures were used for special problems.

Density and refractoriness are relative terms and the distinction between dense-burning and open-burning, refractory and non-refractory, depends upon the purpose for which the clay is to be used. A clay which is refractory to the porcelain manufacturer may be non-refractory to the primitive potter. Therefore, special definitions are required for their application in the study of prehistoric pottery. Tentatively, until more general tests can be made, a clay which fluxes below 1200° C. (or cone 4) is considered non-refractory and one which has 10% or more apparent porosity at 1200° C. is classed as open-burning. The importance of considering the effect of temper if these two tests are used to compare the clay base of pottery rather than pastes, has already been pointed out. Although this system of classification necessitates firing experiments and special tests, it is based on significant properties which are easily measured, whereas the facts necessary for a geological or mineralogical classification cannot always be determined with certainty from the pastes alone.

Chemical analysis is used by the ceramist to determine the presence and amount of elements which will affect the properties of the fired clay; for example, a high

[1]These definitions are essentially the same as those suggested by Dietrich for commercial purposes: 1928, pp. 251-252.

percentage of alumina indicates a refractory clay, a large amount of silica is characteristic of a sandy clay, the percentage of iron and its ratio to certain other elements largely influence the color of the clay, the presence of carbon and sulphur shows the rate of firing necessary for complete oxidation and the prevention of bloating and black-coring. Many of these properties can be measured more quickly and directly by firing experiments, but the chemical analysis is perhaps particularly advantageous for determining the impurities which cause defects in firing. In the study of pottery, chemical analysis would facilitate the identification and comparison of clays, were the body clay unmixed with tempering material, but as most pastes were tempered, (a great variety of materials and different quantities having been used for the purpose), chemical analysis can give only bulk composition. If the mineralogical composition and quantity of temper is determined petrographically, it is possible to calculate from this data and the bulk analysis the approximate composition of the clay. However, these results are seldom sufficiently accurate for comparative purposes. Slip clays unlike body clays were rarely tempered and therefore a chemical analysis gives their true composition. But slips are usually thin and it is a tedious and difficult task to remove sufficient material, free from paste, for chemical analysis. This method may, therefore, be regarded as a last resort in the study of pottery clays.

All of the tests, with the exception of the porosity determination, which have been suggested for the study of body clays are also applicable to the study of slip clay and since slip clays are in general untempered their texture and mineral inclusions represent those of the clay itself and should be recorded. The principal properties considered in the selection of a slip clay are color, hardness and texture. There are conspicuous examples among Pueblo wares of the use of clays unsuitable for slips, such as the "fugitive red" slips, which were not made permanent by firing, and the soft slips of Mimbres classic, Black-on-white ware, which scaled and were soon abraded with use. The fact that clays which will burn to a light and pleasing color are not common in the Pueblo area probably resulted in the use of many which in spite of good color had other marked disadvantages. The permanence and durability of slips depend largely on the hardness which the clay attains on firing, while the smoothness and the degree of luster which can be produced by burnishing are influenced by texture. These properties should therefore be accurately recorded (see suggestions pp. 442-443).

The procedures for the study of clay which have been discussed relate to the properties of the fired body but give no idea of the working qualities of the raw material. Occasionally slight indirect evidence of these is preserved in the pottery itself. One of the potter's first problems is to prevent her vessel from cracking when it is dried, and the addition of tempering material, which reduces shrinkage, accomplishes this purpose. Thus, if one paste is heavily tempered and another sparsely tempered it is probable that the former had higher shrinkage than the latter, although the proportion of temper used is only suggestive, because clays admit considerable variation, which also necessarily resulted from the potter's methods. Evidence of the use of a short or non-plastic clay is sometimes observed in the cracks along the edge of a coil in corrugated ware, but if the coil was flattened without

developing cracks the clay must have had good plasticity. Direct tests of the raw clay are essential, however, for a satisfactory understanding of its working quality. Hence the importance of preserving all ceramic materials found in ruins and of investigating the clays of the immediate vicinity. If the identity of any of these raw clays with the pottery clay can be established by comparing their thermal behavior and physical and optical properties at given temperatures, then the original working quality of the pottery clay can be tested.

The properties of the raw clay which most directly concern the potter are plasticity and shrinkage. Not only has plasticity never been satisfactorily defined or fully explained, but an exact, standard method for its measurement has never been devised. The experienced potter judges plasticity by feel. Simple tests are also sometimes made, such as forming a ball between the palms of the hands and observing how much it can be flattened without developing marginal cracks or rolling out a coil of clay and ascertaining how thin it can be made without breaking apart. But these are only rough estimates. More direct methods, such as measurement of the stress which can be applied, are not highly accurate because of the difficulty of keeping the clay in a uniform condition with regard to moisture while the test is being made. Indirect tests, such as measurement of colloidal content and the amount of water required to bring the clay to the plastic state, have been proposed, but although these properties affect plasticity their relation to it varies and therefore they cannot be considered satisfactory. A simple method which gives an estimate of cohesiveness and furnishes a basis for comparison has been used in the present investigation. The procedure is as follows: the clay is first air dried and screened through a No. 40 sieve. Water is then added and the mass kneaded until it develops a given resistance to pressure. This standard condition is reached when a rod weighted to 250 grams, sinks a distance of 26 mm. into the clay in thirty seconds. In order to reduce friction against the sides of the rod a wider tip is used, the diameter of the rod being 2.6 mm. and the tip, 4 mm. in diameter by 2 mm. in height. An estimate of cohesiveness is then made by measuring the weight which a rope of clay will hold without breaking. Clay which has been worked to the standard consistency is placed in a grease gun having an opening 12 mm. in diameter through which the clay is forced. In order to attach a small pail to receive the weight, the clay is pressed into a cage (made from a wire coil) having the same diameter as the opening of the grease gun. A hook on the disk at the bottom of the cage holds the pail and the clay which is squeezed between the wire coils gives a better hold than a clamp. After the cage has been attached, a rope of clay 22 mm. long is forced out, and No. 8 shot poured at uniform rate into the pail until the rope breaks. Cohesiveness is then expressed by the number representing the weight in grams required to break the rope.

The water required to bring the clay to its best working condition, called water of plasticity, bears some relation to the plasticity of the clay, for in general the more plastic the clay the more water will be required to develop the best working consistency. The per cent water of plasticity is calculated as the difference in weight of a test piece in the plastic condition and when dry, taken in terms of its dry weight.

Shrinkage is an important property of clay since if excessive it causes vessels to crack upon drying. Shrinkage is affected by the per cent water of plasticity because the greater the amount of water taken up the greater the loss and consequent contraction upon drying. Either volume or linear shrinkage can be measured. Linear shrinkage is determined by placing two sharp marks accurately spaced on a test piece when it is in the plastic state; the distance between the two marks is measured when the piece is dried and the per cent drying shrinkage calculated by taking the difference in distance between the marks on the wet and dry test piece in terms of the original distance. The greater the distance between marks the more accurate will be the estimation and if a simple unit of one hundred is taken calculation will be simplified. Fifty millimeters have been found a convenient distance.

The study of clays is involved and difficult and a review of even a few of the factors to be considered and the cautions to be observed is very likely to leave an impression of hopeless confusion and uncertainty. Many of the procedures discussed are tentative and represent merely an effort to make a start in the study. The most promising procedures are the study of optical and physical properties at known temperatures while color, density and refractoriness offer a convenient and significant basis for classification. The study will progress in proportion as exact tests are applied and the actual complexity and variability of clay will often prove an aid in identification and always a stimulus to research.

Identification of Tempering Material

Pottery is seldom made from clay alone. The modern ceramist adds to his clay powdered silica and feldspar or grog. The primitive potter likewise has generally used some form of non-plastic material unless her clay was naturally sandy or gritty. A great variety of inclusions have been found in prehistoric pottery including sand, crushed rock, volcanic ash, ground potsherd, limestone, and shell, the material used depending both upon the custom of the potter and what was afforded by her environment. This non-plastic material or temper, as it is called by American archaeologists, serves several purposes. It reduces shrinkage and the danger of cracking both mechanically and by lowering the total surface area of the particles of the mass and consequently the amount of water required to bring the clay to the plastic state. Temper also lessens the stickiness of clay and unless low in plasticity the tempered clay is easier to handle. More important is its function in firing; by coarsening and opening the texture of the body it permits the more rapid escape of gases which if held in the dense clay would cause spalling, blistering or bloating. The effect is especially important when vessels are heated rapidly as in primitive direct firing. Whether or not the primitive potter recognized the value of temper in firing we have no way of knowing, but experience must have taught her some of its advantages and correction of shrinkage is undoubtedly the most conspicuous one. The one disadvantage in the use of temper is the fact that it weakens the clay. Archaeologists have sometimes erroneously referred to temper as a binder, probably

visualizing it as forming a bond because it prevents cracking; but clay with its high cohesion is obviously the binder and the temper simply prevents excessive shrinkage.

The study of tempering material is of interest to the student of pottery who would trace changes in technique because of the wide variety of materials utilized, but it is also of more general interest because it frequently gives the clearest evidence of the provenience of pottery. The sands and rocks used are often so distinctive that their exact source is established beyond question. But such data demands exact and detailed identification. A hand lens has often been used to detect tempering material and in the coarser-textured pastes it is sometimes possible to distinguish by this means fragments of rock, sand, or sherd. Exact petrographic determination of the temper in pottery types which are described in archaeological literature, shows, however, that many of the identifications made with a hand lens are incorrect. Repeated tests by experienced individuals, moreover, prove that the method is not entirely reliable. In the technological description of Pecos types, the proportion of sherds in which the kind of temper can be identified with a 10-power lens, and the particular characteristics which should be observed, are discussed. It will be found that the temper cannot invariably be recognized megascopically in any of the types occurring at this site, with the possible exception of certain of the culinary types; none of the fine-textured types can be identified with the hand lens, and the paste of half of the sherds of decorated wares is fine-textured. This partially illustrates the limitations of megascopic examination. An equally serious objection is the fact that specific identification can never be made in this way. The kind of tempering material used reflects the custom of the potter, but in order to discover the source of materials a detailed analysis of the mineralogical composition is necessary; the accessory minerals in a sand, for example, may show the drainage from which it came, or rock temper may be definitely traced to a particular outcrop by detailed petrographic analysis. The petrographic microscope is essential and invaluable in this phase of the work. The importance of microscopic analysis in ceramic studies is well established. It is used in modern ceramic investigations, particularly in the study of thermal changes of ceramic bodies, to determine, for example, the degree of solution of quartz and the formation of mullite and sillimanite. Likewise its application in archaeological studies is not new, for Nordenskiöld reported the analysis of thin sections of Mesa Verde pottery in 1893 and more recently Linné has published results of petrographic examination of South and Middle American types.[1] Nevertheless, the possibilities of this method as a means of revealing the technological history of pottery have been barely touched.

The use of the petrographic microscope, no less than chemical analysis, requires specific training. Minerals are not identified by their appearance as viewed in polarized light, but by exact measurement of certain optic properties, and the importance of accurate identifications cannot be overemphasized. Descriptions of inclusions which "look like quartz" or "are green and probably either hornblende or a pyroxene" have occasionally appeared in archaeological literature and are obviously worthless. If an accurate determination cannot be made it is better to wait than to give a report this fallacious guise of scientific method.

[1] Nordenskiöld, 1893, pp. 78, 81, 84. Linné, 1925, pp. 29-60; 1929, pp. 261-269.

Since the principles of optics and petrographic methods of analysis are fully covered by texts and constitute a special study, only certain adaptations need be discussed here. The method of identifying mineral inclusions in pottery does not differ essentially from the geologist's procedure in studying a thin section of rock, for primitive pottery was not fired high enough to develop artificial minerals and relatively few—certain hydrous minerals and carbonates—are changed. However, the mineral fragments are often exceedingly small and it is necessary to acquire experience in determining optic properties of very fine-grained material. The petrographic microscope is used for the examination of both thin sections and powdered materials immersed in refractive liquids. The thin section shows the shape, arrangement, size and quantity of inclusions, and the texture and relations of paste, slip, paint and glaze. In some instances even, the thin section is necessary for the identification of temper; potsherd fragments can seldom be recognized in powdered paste and while the mineral components of a rock may be identified in this manner the rock itself cannot be studied. Although the preparation of the thin section requires time and a certain degree of skill it furnishes a valuable and permanent record.[1]

The study of powdered material immersed in liquids of known refractive index is also an essential part of microscopic technique and is used especially in determining refractive indices, since in thin sections this property can be estimated only by comparing the unknown with the mounting medium or an adjacent mineral. The thin section shows a relatively small sample, and it is often advantageous to examine a large amount of powdered material in incident light with the binocular microscope; then particular minerals can be picked out with a needle, immersed in a refractive liquid and all of their optic properties recorded. The refractive liquids save considerable time when it is necessary only to identify the minerals present.

General classes of tempering material can be determined with the binocular microscope in all but the finest-textured sherds. Sand, sherd, volcanic ash and different colors and textures of igneous rock can be distinguished, but this instrument does not give the mineralogical detail necessary to locate the source of materials, and it is most effectively used in conjunction with the petrographic microscope. The binocular microscope is particularly useful for classifying large lots of stratigraphic material, after the types have been fully defined by the petrographic microscope, which should always be at hand to check doubtful specimens.

[1]The softness and friability of pottery necessitate impregnation with bakelite for the preparation of thin sections. The method is described in the following papers:

Ross, 1924, 1926. Legette, 1928.

It is often desirable to slice the sherd diagonally through the vessel wall, since a cross-section gives only a small specimen and a longitudinal section does not include slip or pigment, nor are the possible paste variations occurring from core to margin represented. A number of grades of bakelite, varying in viscosity, color and the rapidity with which they can be hardened, is on the market. Legette recommends C.V. 1305 which has been found satisfactory for impregnating pottery but a thin lacquer (B.L. 3128) has certain advantages; it is lighter colored and can be heated more rapidly. As it is less viscous the pottery chips, which have been soaked and air-dried, are given a second dip to leave a reasonably thick coat on the surface. More complete penetration of bakelite is obtained if chips are boiled in bakelite solvent previously to impregnation. The impregnated chip can be heated with less danger of blistering if first thoroughly air-dried.

The identification of the rarer mineral inclusions is facilitated if they can be concentrated by separation from the paste and more common minerals. This is particularly true in the case of sand-tempered wares in which accessory minerals may serve to differentiate the sand of different drainages. Methods of separation developed in petrographic studies, and applied particularly in the study of sediments, may be useful. Separation with an electromagnet and with heavy liquids have both been tried, but the success of the latter method especially depends upon completeness of separation of minerals from paste, since particles of porous clay adhering to small mineral grains cause them to float in the heavy liquid. The applicability of the method for pottery analysis is partially determined by the softness of the paste. With very low-fired wares it may be possible to effect a more complete separation by preliminary digestion in sulphuric acid, which would attack some fired clays but few of the principal minerals. The procedure has not been checked in the Pecos study because most of the types are relatively well fired and electromagnetic separation has been more satisfactory than heavy liquid separation.

The approximate percentage of tempering material in a paste can be estimated from thin sections. The Rosiwal method employed by petrologists to calculate the percentage of given minerals in rocks is useful for this purpose. It is based on the principle that "along any line of adequate length drawn on a plane surface—the ratio of the sum of the linear intercepts of any given mineral to the total length measured across the rock-surface is approximately equal to the volume-percentage of that mineral in the rock."[1] The total length of the lines along which constituents are measured should be at least one hundred times the average diameter of the particles measured. In order to insure greater accuracy, a line two hundred times the average diameter of the constituents was taken in the Pecos study. Measurements should be made at uniform intervals over the section to avoid any unconscious tendency to select fields, and to insure an even sampling of the section. Both margin and core of the sherd should also be included in the count.

The accuracy of this method when applied to ceramic determinations was tested with pastes of known composition. Test pieces were prepared with clay from Zuñi tempered with 15 and 25% by volume of sand, rock and sherd, the rock and sherd being sifted and recombined after grinding to duplicate sand in grain size. These samples, together with untempered clay as a control, were fired to 1030° C. and thin-sectioned for counts. The results showed that a high degree of accuracy cannot be claimed for the method when applied to pottery but errors are small compared with the variation in amount of temper present in different sherds of the same type. When well prepared sections, in which the temper can be clearly distinguished from the paste, are used and the utmost care is exercised in counting, the average error does not exceed 10%, that is, the count will give a minimum of 22.5% in a sherd which actually contains 25%. Compared with this error the amount of temper in sherds of a single type has been found by this method to vary from the average anywhere from 18 to 60%. The average variation for nine representative Pecos types was 28%. In other words, the more sparsely tempered sherds of a type

[1] Holmes, 1930, p. 311.

averaging 25% temper will contain only 18% and in extreme cases no more than 10%. The Rosiwal method can be used to determine the percentage of all granular-textured temper but is not reliable for platy or needle-like material, especially as these were sometimes oriented when the vessel was shaped. Tuff and mica are the only examples of this type of temper so far encountered. Mineral matter occurring naturally in the clay is not distinguished from the artificially introduced temper in these counts, but the non-plastic material of the clay generally constitutes a very small percentage of the total mineral inclusions. The unequal change in the volume of temper and of clay caused by firing shrinkage introduces a comparatively slight error. The two principal sources of error in the application of the Rosiwal method are careless sampling and inaccurate measurement. A sufficient number of measurements must be taken in each section to insure an exact record of that specimen and furthermore enough sherds should be measured to represent the type. Difficulty in measurement may arise either from indistinct boundaries or from similarity of the clay base and temper. If the boundary of a crystal is oblique to the plane of the thin section there will be an overlapping film of clay and the edge of the crystal will not be sharply defined. Moreover certain types of temper may be so like the clay in color and texture that they are not seen, as for example sherd tempering fragments which are similar in appearance to the clay base. Judgment must therefore be exercised not only in sampling but also in deciding whether a type can be measured with sufficient accuracy to give reliable data. Under favorable conditions the calculated percentage approximates the proportion of temper used by the potter and forms a basis for comparing the average amount of temper in different wares and also the degree of variation within a ware.

The possibility of removing certain kinds of temper by chemical treatment offers another means of calculating the proportion of temper in a paste. If a non-calcareous clay, for example, is tempered with calcite, limestone or shell, the amount of temper can be estimated by removing the calcium carbonate with hydrochloric acid and comparing the original weight of the paste with either the weight of the washed and dried residue left by acid treatment or with the calcium carbonate precipitated from the filtrate.

Since volume of temper can be calculated there is need for specific definition of quantitative terms. On the basis of experience with Pueblo wares the following terms have tentatively been applied:

Sparsely tempered	under 15%
Moderately tempered	15 to 30%
Heavily tempered	over 30%

The average grain size of tempering material has been calculated by averaging the diameters of one hundred grains in a section. To avoid unconscious selection only the grains which come under the micrometer scale are measured, and the slide is shifted to bring the scale on fields uniformly spaced over the section. These estimates of grain size can be used to compare types but are lower than the true value because the thin section cuts through the greatest diameter of only a portion of the grains, others being only grazed and cut in all positions intermediate between

these two extremes. Petrographers have worked out a formula for correcting this error, but it applies to specimens in which the grains are of nearly equal size and consequently cannot be used to correct estimates for sherds in which there are great differences in grain size. The maximum diameters measured will represent the true maximum if a large enough section is used to insure interception through the center of some of the largest inclusions. It was found in the study of Pecos material that the average grain size often varies but slightly for sherds which differ noticeably in distribution of sizes of inclusions; thus a high proportion of fine material will equalize the average for sherds with large amounts of medium-textured grains and those with a moderate amount of coarse material. A determination of the percentage of fine, medium and coarse material is therefore more significant than the calculation of the average size. Definition of textural terms is necessary for this purpose and the following standards, based on those used by petrographers for the description of sediments, have been adopted for this study:

Textural Terms	*Diameter of grain in mm.*
Very fine	0.05-0.10
Fine	0.10-0.25
Medium	0.25-0.50
Coarse	0.50-1.0
Very coarse	1.0 and above

In geological usage the limits here specified for coarse, medium, and fine define these grades of sand; and very fine corresponds to coarse silt. Coarse sand falls between the limits of 1.0 and 2.0 mm. and gravel between 2.0 and 10.0 mm.[1] Five hundredths of a millimeter has been taken as the lower limit in the definitions adopted because in this range an increasingly large proportion of the grains may have occurred in the clay and, since we are concerned with the temper, an arbitrary limit must be fixed. The largest of the medium particles can be seen with the unaided eye, and the medium and largest of the fine with the aid of a 10-power hand lens under favorable conditions, that is, with distinct color contrast between paste and inclusions. But it is not necessary or practicable to base the definition of terms upon the range of sizes detected megascopically because these will differ with the degree of color contrast in materials. Some workers will find that the definitions proposed do not correspond with their conception of these grades. In certain Mississippi Valley pottery types, for example, much of the temper is considerably coarser than 2.0 mm. Experience will prove whether it will be advisable to expand the standard definitions evenly to divide the entire range of grain sizes found in pottery, or whether it will be more practical to use special terms for these somewhat exceptional materials. The first alternative would have the disadvantage of making too broad the terms which cover the range found in the majority of pottery types. The word gravel might possibly be used, or textural terms applied to an exceptional kind of temper could be defined independently; "coarse shell," for example, might describe

[1]See Holmes, 1930, p. 197.

a different size than "coarse temper." The problem will have to be worked out by those familiar with the range of materials, and the number of subdivisions required in the Mississippi Valley. The subdivisions established in geological usage have been found adequate and satisfactory for the description of both Southwestern and Middle American paste textures.

The number of sherds which should be analyzed for the petrographic description of a type will naturally be decided to a certain extent by its variability. Usually an examination with the binocular microscope will show the range of textural and mineralogical variations occurring within a type defined by surface features and so furnish a guide for the more detailed study.

The results of petrographic analysis of pottery cannot be fully interpreted without a knowledge of the geology of the locality from which it comes. In many regions available geological data do not give the detail necessary for the exact location of sources of material and in such cases special studies must be made. The nature of these will be suggested by the particular ceramic materials found. Often it will be desirable to compare the sand of streams draining different formations and to study the minor textural and mineralogical variation in igneous outcrops.

Temper is one of the most diverse of ceramic materials and it is also the most readily and accurately identifiable. The Pecos study will give some idea of the character and importance of results which can be obtained when a large variety of materials were used and geological provinces are sharply defined. It is believed that these data justify thorough analysis correlated with systematic geological field work.

Analysis of Pigments

The study of ceramic pigments involves, in addition to the identification of the substances used, a consideration of the viscosity or spreading quality of the raw material, the physical relations and possible chemical reactions between pigment and clay, and the effect of firing upon composition, color and permanence of the pigment. Chemical analysis, thermal experiments and microscopic examination all contribute to the investigation. Microscopic examination shows the thickness, texture and homogeneity of the paint and its depth of penetration; chemical analysis offers the most satisfactory means of identification, and when the composition is known, thermal experiments aid in the study of effects of firing and causes of permanence. One of the principal difficulties in identification is that of obtaining a sample of sufficient size for chemical analysis yet free from slip or body clay, for the paint is often exceedingly thin and sometimes penetrates and stains the slip or body so that it is practically impossible to distinguish pigment from discolored clay. A number of investigators have reported analyses of Pueblo ceramic pigments; the work of only a few need be reviewed to illustrate the various methods which have been employed.

One of the earliest chemical analyses was published by Nordenskiöld in 1893.[1] He determined that the paint of certain Mesa Verde vessels has an iron base and

[1] p. 84.

inferred, from the discovery of a mixture of hematite and resin on a stick, that the paint was applied in the ferric state and reduced during firing by the admixed organic matter. Nordenskiöld does not describe the method of analysis used, nor does he seem to have discovered that the paint of classic Mesa Verde ware is organic in composition. The pigments of certain Black-on-white types from Chaco Cañon and Mesa Verde were analyzed by Germann, the material for these tests having been removed from the sherd by digestion with hydrofluoric acid previously to analysis and the form of oxide present determined by the magnetism of the paint particles.[1] A simple means of distinguishing between organic and iron paint by oxidation was used by Hawley.[2] This method depends upon the fact that many pigments containing iron will redden when treated with hydrofluoric acid and heated in an oxidizing atmosphere, while under the same conditions carbonaceous matter burns out, leaving only the ash. The test is therefore non-technical and has since been adopted by a number of archaeologists. But it is limited to the determination of only two kinds of paint and often more refined methods are desirable. Also certain theories—as, for example, the supposition that plant juice was always used with mineral paint, and that the permanence of organic paint was due to a protective silicate film—were advanced without experimental demonstration and consequently have been misleading and have resulted in erroneous conclusions. Gonyer substituted for the oxidation method the potassium ferrocyanide test for iron, applying the reagent directly to the paint surface which had previously been digested with acid.[3] Although the ferrocyanide test for iron is preferable to oxidation, the application of acid and reagent to the sherds is not to be recommended because it is impossible with this procedure to keep the pigment free from slip.

Most investigators have used acid, either hydrofluoric or a mixture of hydrofluoric and hydrochloric, to loosen the paint from the clay surface previously to analysis. Digestion with hydrofluoric acid is also recommended for the Hawley tests because the paint is then more readily oxidized. Hydrofluoric acid, however, attacks the clay as well as the pigment, and although the latter is usually the more soluble of the two, an indefinite amount of clay will be included with the sample if it is removed with acid treatment. On the other hand, if the test is made on the sherd and, as with either the Hawley or Gonyer methods, acid is allowed to flow across the surface, some of the pigment may be carried off in solution. Hawley discusses the solubility of clay and pigment and mentions certain very necessary precautions.[4] But even with experience and caution the procedure is not always reliable. The mechanical removal of paint is an alternative for acid treatment, but requires care and patience. The process should be observed with a binocular microscope to avoid cutting into the clay, and a steel tool cannot be used if iron determinations are to be made.[5] A crystal of carborundum properly mounted makes a convenient scraping tool, since it cuts rapidly, being considerably harder than either steel or quartz. Carborundum is an artificial compound of carbon and silicon, and

[1]1926, pp. 480-482. [2]1929, pp. 731-754. [3]Cosgrove, 1932, p. 94. [4]1929, p. 74.

[5]The possibility of removing extraneous iron with an electromagnet was tested, but the method proved unsatisfactory because the iron adheres to the particles of pigment, and the greater part of the sample is consequently attracted by the magnet.

though these two elements would be introduced into the sample with the abrasion or flaking of the scraping tool, they do not interfere with the determination of the metallic elements. Certain types of mineral paint which have no relief and appear to have penetrated the clay as freely as would soluble organic paints are particularly difficult to remove by scraping. In such cases a drop of hydrofluoric acid carefully applied will loosen the surface and upon drying, the pigment can be removed by scraping. The particular method which is selected for removing paint will depend upon the nature of the materials and the problems involved, but it is often advisable, as a final precaution against contamination of the sample, to test the slip as well as the paint; then if the principal elements found in the paint sample do not occur in the slip, the analysis represents the composition of the paint. If the same elements are present in both slip and paint, special care and judgment must be exercised in obtaining the sample and interpreting results.

Techniques which have been developed for the analysis of minute quantities of material are distinctly advantageous in the study of ceramic pigments. Microchemical analysis has been found satisfactory for the qualitative determination of many elements occurring in paints and glazes. The polarizing microscope is utilized in this method to identify elements, principally by means of reaction in which readily identifiable crystalline compounds are formed.[1] Microchemical analysis does not generally require separation of the sample, as in the usual procedure for qualitative analysis, and consequently substances which interfere with certain reactions may be present. This restriction necessitates a thorough knowledge of all reactions and possible effects of interfering elements. Tests which have been found reliable in the study of Pueblo pigments include the potassium thiocyanate test for iron, the sodium bismuthate test for manganese, the potassium iodide test for lead and the potassium mercuric thiocyanate test for copper. Spectrographic analysis is especially adapted to exact qualitative analysis of small samples and may also be used for approximate quantitative determinations, but the expense of equipment limits the use of this method for archaeological work.

Quantitative analysis is sometimes necessary for the solution of specific problems, but requires larger samples than qualitative determination. If the composition of the clay is known, the amount included in a sample of mixed pigment and clay can be determined and deducted from the analysis. It might appear feasible, therefore, to calculate the composition of the paint in this way, rather than to obtain a sample of paint free from surface clay. The method is not generally practicable, however, because a hard, thin slip is almost as difficult to remove as the paint; moreover, the mixed sample of pigment may contain an uncertain amount of body clay, as well as slip clay. It is therefore advisable to work with unmixed samples and it has been demonstrated that, with highly accurate instruments and experience in dealing with small samples, the usual procedure for quantitative analysis can be carried out with a ten milligram sample.

Pueblo potters used both organic and mineral paints; the former were of vegetable origin and the latter included oxides of iron and of manganese, and ferruginous

[1]For a discussion of microchemical methods and description of tests see Chamot and Mason, 1931.

and white-burning clays. Black was produced with either vegetable or mineral substances, while reds, yellows and whitish colors were obtained with clays. Each type of paint presents specific problems. The argillaceous paints are usually similar in composition to slip clays, having been chosen for their color and texture. Methods for their identification and description are, therefore, covered in the section on clays. The iron and manganese paints are readily identified by microchemical tests and oxidation is the simplest means of recognizing an organic pigment.

One of the principal requirements for a ceramic pigment is that it withstand firing; consequently, the decoration of pottery with organic matter seems anomalous. Various theories have been advanced to explain why the carbon from a vegetable paint is not burned out in firing. Tests made in an effort to learn more about the conditions favorable to the successful use of organic paint will illustrate the fact that identification of the substance is only one of many problems which arise in the study of ceramic pigments. The standard black paint used by present-day Pueblo potters of San Ildefonso, Tesuque, Cochiti, and Santo Domingo is an extract of the Rocky Mountain Bee Plant (*Peritoma serrulatum*), commonly called *guaco* by the native peoples. The preparation of this paint by San Ildefonso potters had been described by Guthe.[1] *Guaco* is also used by Zuñi potters as a vehicle for mineral paint.[2] It is reported that the Hopi mix the concentrated juice of a species of tansy mustard (*Sophia sp.*) with mineral paint.[3] As a result of the general use of the Bee Plant the idea has become prevalent that it possesses some peculiar properties which make it especially suitable for ceramic purposes. There is no excuse for the persistence of this idea, which is almost akin to a superstition, for the question whether the juice of certain plants only will produce black when applied to raw clay and given short rapid firing is very easily answered by experiment.[4] A number of organic substances including the concentrated extract of a species of chenopodium, mock orange, dandelion, licorice, sugar, glucose, honey, glue, starch and gum tragacanth have been compared with *guaco;* applied on the same clays and with the same firing treatment, they produce black or dark gray similar to that obtained with *guaco.*

The fact that substances as different in appearance as sugar and the dark gummy juice of the *guaco* will both fire black has been recognized by certain of the Pueblo potters, for they sometimes add sugar to their *guaco* paint. There are a number of things in addition to fired color which may account for the use of a particular plant for vegetable paint: abundance, succulence and ease with which the juice is extracted, spreading quality, rate of drying and color before firing. The Bee Plant is an abundant annual in the vicinity of the Pueblos. The concentrated juice has sufficient body or viscosity to flow well from the brush and being of an olive color

[1]1925, pp. 25-26. [2]Stevenson, 1904, p. 375.

[3]Hawley, 1929, p. 738, Colton, June, 1931, p. 3.

[4]Some years ago Mr. K. M. Chapman became interested in this question and tested various plant extracts. He fired paints made from the concentrated juice of dandelion, mock orange, a species of chenopodium and also licorice, and could distinguish none of these from *guaco.* Mr. Chapman also recognized that Santo Domingo slip held organic paints better than some other slip clays used by the Pueblos.

shows up against the clay. It also dries quickly. A sugar solution, of the same concentration as the *guaco*, being more fluid tends to spread. It is also nearly colorless so that the design cannot be clearly seen and as it dries slowly, care must be taken to avoid smearing it. On the other hand, gummy substances such as glue or starch paste are so cohesive that they peel off upon drying, unless very thinly applied. Even *guaco* may increase the crazing of certain slips by its excessive contraction and this effect is lessened by the addition of sugar. While *guaco* possesses advantages its use has also been fixed by custom, which undoubtedly enters into many of the ceramic practices of the Indian.

A plant extract such as *guaco* consists primarily of carbon, oxygen and hydrogen united in complex organic compounds. When heated these compounds are broken down, volatile matter is driven off, and free carbon is deposited on the clay. The chief problem in connection with these paints is to explain why the carbon does not also burn and so escape as carbon dioxide gas, leaving only a trace of plant ash. As a matter of fact, these paints can be burned out with prolonged heating under oxidizing conditions; but the rapidity and completeness with which they burn varies considerably; thus a gray streak remains on some after they have been held at a temperature between 800° and 840° C. for half an hour, while no trace is left on others.[1] It has been found that organic paint is much more easily oxidized if it is first treated with hydrofluoric acid. In explanation of this fact it has been suggested that the carbon is protected by a very thin coat of an alkali silicate formed by the reaction of alkali salts in the plant ash with the silica of the clay.[2] A partial analysis of ash from an organic paint, containing 28.5% ash, of which 8.2% was silica and 32.5% alkali, is given in support of this theory.[3] An incipient glaze is not visible on the surface of these organic paints even upon microscopic examination; moreover, after *guaco* paint is fired, a coat of powdery ash, which is easily brushed off,

[1]Clays having a very low vitrification point may begin to sinter at the temperature employed in Pueblo firing and if this occurred organic matter would be trapped and protected. Sintering of the clay may possibly explain the tenacity with which organic paint is held on some types of prehistoric sherds but was seldom an important factor.

[2]Hawley, 1929, p. 739.

[3]Hawley, 1929, p. 739. The Hawley analysis would have been more significant had the history of the sample been known, for the amount of ash in organic pigments varies within wide limits, depending upon the method of preparation. The plants, as gathered, contain a variable amount of siliceous dust. Furthermore, after concentration by boiling, the liquid is air-dried or sun-dried, during which time it is exposed to dust. Any organic extract handled in the same way might have a high silica content. Paint made from Bee Plant which was washed before extraction and the extract concentrated indoors contained 0.45% silica as compared with 8.2% found by Hawley. When the juice of the Bee Plant is concentrated by boiling, an insoluble salt separates. This salt may amount to 13% of the sample, though part is sometimes included with the paint; but when calcined it is reduced one half, so adds only 6.5% to the ash. It is composed principally of a calcium salt, which was not positively identified. However, it is none of the common, sparingly soluble, salts of calcium—the sulphate, carbonate, phosphate or oxalate. When burned to an ash it yields calcium carbonate, equivalent to the amount obtained from burning calcium citrate, and when the salt is dissolved in hydrochloric acid it is not reprecipitated by the addition of ammonia except on boiling. This reaction is characteristic of calcium citrate. Paint in which the soluble salt had been retained was compared with that from which it had been rejected and no positive effect of this part of the ash upon the carbon was noted. In preparing paint from the Bee Plant it was found that the juice becomes dark and less soluble if dried at 100° C.

usually covers the surface; therefore, it is evident that at least a considerable part of the ash does not enter into the formation of a glaze. The theory of the protection of carbon paint by a thin silicate film was tested in three ways: by comparing the permanence of ash-free organic substances with that of *guaco*, by determining whether the relative permanence of ash-free substances was improved by the addition of salts equivalent to the ash of *guaco*, and finally by testing the effect of partial removal of ash from *guaco*.

Sugar was selected as an ash-free substance for comparison with *guaco*. Solutions of each were prepared in the same strength (29 parts of pigment to 71 parts of water, which is the concentration used by a Cochiti potter). Lines were drawn with the two solutions on various types of slip clay, the brush being dipped for each stroke. The slips were prepared by mixing the same weight of clay in a given amount of water and each trial piece was given the same number of applications and the same degree of polish. Test pieces were fired in an electric resistance furnace with accurate temperature control to 850° C. in thirty minutes. Under these conditions, in which all factors were constant except composition of paint, the depth of black on the different clays varied greatly whereas the sugar and *guaco* differed but slightly, the former being a little deeper and more even in color on those clays which took the organic paints most effectively, and somewhat weaker on the clays which did not hold any organic pigment well. As an additional test, the trial pieces were broken in two; one part was refired to 850° C. and held between this temperature and 840° C. for twenty minutes. Also duplicate trials were carried to 950° C. in thirty minutes. The results of these two heat treatments were hardly distinguishable; the carbon had been completely oxidized from some clays, while a dark gray streak remained on others; likewise the *guaco* was stronger in color on certain clays while on others the sugar was more resistant to oxidation.

The effect of the addition of alkalies and silica to ash-free organic substances was tested by adding sodium carbonate and sodium silicate to sugar and to lampblack in amounts equivalent to that in the *guaco* analyzed; 25 and 40% solutions of wood ashes were also added to these two substances. To eliminate the possible effect of soluble salts in the clay, both body and slip clays were washed by repeated decantation with distilled water. The solutions were compared with sugar alone and with *guaco* by painting them on test pieces which were fired to 850° C. and held for twenty minutes. The substances to which alkali and silica had been added were no more resistant to oxidation than the normal sugar solution.

An attempt was made to remove the alkali from *guaco* by dialysis, but some of the salts are evidently organically combined and cannot be extracted in this way. But a dialyzed sample of *guaco* from which 27% of the original ash had been removed was compared with normal *guaco*. When fired rapidly to 850° C. and also after being held at this temperature for twenty minutes the normal and dialyzed *guaco* were indistinguishable.

Another possible effect of the ash in plant extracts was considered; that is, even though not combined as a silicate or fluxed, it might have a protective or fire-proofing effect on the carbon. It is a common practice in the determination of ash to dissolve the coating of fusible salts if the carbon is difficult to oxidize, for

after this treatment the carbon burns off readily. The coating of ash on organic paint might also considerably prolong the time required for oxidation. To test this theory trial pieces were painted with *guaco* and fired rapidly to 850° C. One of these was then boiled in distilled water for twenty minutes, while the coating of ash on the other was undisturbed. Subsequent refiring to a temperature of 850° C., which was held for twenty minutes, oxidized the undisturbed specimen as fully as the one from which the ash was entirely removed.

These experiments show conclusively that organic paint of the type used by the Pueblo potter is not protected by a silicate film and that ash is not an important factor in reducing the rate of oxidation of carbon during the firing of these pigments. Other factors should be considered in explaining the minor differences noted between *guaco* and sugar in resistance to oxidation. It is well known that carbon from different sources varies and that some kinds burn more readily than others. Lampblack from the partial combustion of oil and carbon black from natural gas are common examples of the variation in carbon. The coking of coal is analogous to the combustion of organic paint; most bituminous coals yield soft coke and comparatively few yield a hard metallurgical coke capable of sustaining the load in the blast furnace. There is practically no ash in petroleum coke, yet the carbon left in the final breaking down of some tars is hard and dense and has the appearance of having been melted. The carbon from the dialyzed *guaco* was more dense than from the normal *guaco* and required three hours to burn to a white ash under conditions which would have burned the carbon from undialyzed *guaco* in approximately twenty minutes. According to Mellor, the temperature at which combustion begins depends greatly upon the physical condition of carbon, being spontaneous for very fine carbon but not beginning until a temperature of 660° C. is reached for carbon approaching the density of graphite.[1] It is possible that with more detailed study the characteristic form or condition of the carbon together with the particular mineral salts present will specifically identify the source of certain organic paints. The assumption that the Rocky Mountain Bee Plant was always used by prehistoric Pueblo potters is not justified.

The marked variation in depth of color of *guaco* paint, when applied to different clays, has been mentioned. These differences show very plainly that certain properties of the clay perform an important part in the protection of the carbon. The clays tested include Santo Domingo and Laguna slip clays, the carbonaceous pottery clay of Zuñi, buff-burning Cretaceous clays from the Galisteo Basin, red-burning alluvial Tertiary clays from the Tesuque valley and bentonites from Santa Cruz and Vallecitos Creek. The clays which held the *guaco* longest were those which had the highest per cent water of plasticity and shrinkage. Thus the bentonites gave a black at 850° C. and dark gray corresponding to Ridgway's 15′′′′′m on refiring for twenty minutes or firing to 950° C.; the Santo Domingo slip and a clay of similar properties, found in the Galisteo Basin on the bank of the Jara at the mouth of the Cañoncito Colorado, also protected the carbon well, having the color of Dusky

[1]Mellor, 1916, p. 722. Page 718, ignition temperature of charcoal in oxygen, 300°-500° C.; of graphite 650°-770° C.

Neutral Gray (Ridgway's *m*) with the short firing and Neutral Gray or Light Neutral Gray *b* with the longer or higher firing. The Santo Domingo and Jara clays have high adsorption and shrinkage, though they are less extreme in these respects than the bentonites. They resemble the bentonites in optic properties. Their origin has not yet been determined but they do not show the ash structure of true bentonites. The sedimentary clays having average per cent water of plasticity and shrinkage are unsatisfactory for the *guaco* paint, as it fires to Neutral Gray, 15″″″b (Light Mouse Gray) or 17″″″b (Light Drab) at 850° C. and leaves only a faint trace or disappears completely on longer firing. It is also with this class of clays that a poorer black is obtained with sugar as compared with *guaco*.[1] Similar tests were also made with the Jara clay and a white-burning commercial clay obtained from Coors Porcelain Company. These two clays were used as slips and mixtures of the Jara with 25, 33, 50 and 75% of the Coors clay also were used. With the firing treatment previously described the Jara fired to Dusky Neutral Gray at 850° C. and to Neutral Gray on being held at this temperature for twenty minutes, while the Coors clay retained only enough carbon to give a Pallid Neutral Gray *f* on the first firing and burned out completely on refiring. The mixtures of the two clays showed a relatively even gradation in color from one extreme to the other.

The relation of the strength of organic paint to the type of clay used has been recognized by the Pueblo potters, for Santo Domingo slip is preferred by modern Tewas using organic paint, and the San Ildefonso potters obtain it in trade from either Santo Domingo or Cochiti Indians who both use it.[2] Potters of Zia, Laguna, Isleta, Acoma and Zuñi, having open-textured slips which do not retain an organic paint, decorate with mineral pigments. It would be interesting to determine whether the distribution of organic paints in prehistoric times bears a direct relation to the occurrence of clays of the type upon which this paint is most effectively used.

Some clays have the property of adsorbing dye from solution and are used as decolorizers. Clays which are satisfactory for organic paints might be expected to adsorb a larger proportion of the vegetable extract from solution. The relation of the adsorptive property of clays to their protection of carbon was, therefore, tested

[1]The following figures will give an idea of the range in water adsorption and shrinkage of these various types of clay:

	% water of plasticity	*% linear shrinkage*
Zuñi clay	38	12
Cretaceous clay		
Galisteo Basin	32	10
Tertiary Clay		
Tesuque Valley	30	10
Jara clay	62	18
Bentonites		
Vallecito Creek	86	So extreme that they cracked badly and measurements could not be made.
Rio Oso	92	

[2]Guthe, 1925, p. 23. This slip absorbs and holds organic matter so tenaciously that it is necessary to avoid handling a vessel before it is fired, since oil from the fingers is absorbed and leaves a black finger print upon firing.

by adding a *guaco* solution to different types of clays in a water suspension. But the bentonites and clays of similar type did not remove any more of the color than did the common sedimentary clays.

Experiments, in which *guaco* was painted on test pieces given preliminary firing, also prove that the preservation of *guaco* is due to properties of the raw clay. A test piece slipped with Jara clay was fired to 850° C. and then painted; upon refiring to 850° C. (the temperature at which a good black was obtained from *guaco* painted on raw Jara clay) only a faint trace of gray remained. A series of test pieces of Jara clay was then prepared and fired to temperatures ranging from 200° to 500° C. with intervals of 50 degrees between trials. The shrinkage, loss of water, decrease in plasticity and rate of slaking was determined for each. They were then painted with *guaco* and refired to 850° C. in thirty minutes. A direct relation was shown between the strength of the *guaco* paint and the degree of dehydration and consequent shrinkage and loss of plasticity of the clay. The plasticity of the Jara clay was not entirely destroyed until a temperature of 450° C. was reached and the *guaco* was noticeably paler on test pieces which had been fired to or above this temperature. If the permanence of the *guaco* were dependent primarily on the formation of a silicate film, preliminary heating of the clay should have no effect on the depth of color. The two properties of clay which clearly bear a relation to the permanence of organic paint are the water of plasticity and shrinkage, which fact means that a given amount of clay will take up more of the *guaco* solution and that upon drying the clay particles are drawn tightly together thus protecting the films of pigment which surround them.[1] The effect of hydrofluoric acid used in the Hawley tests to facilitate oxidation is readily explained by this theory of the adsorptive and protective effect of certain clays, for the acid attacks the clay, opening and loosening the surface and thus exposing the carbon.

The firing atmosphere, as well as temperature and length of heating, have, of course, an important effect upon the preservation of an organic paint. If a reducing atmosphere is maintained, the carbon will not be oxidized, and a higher temperature and longer firing than is possible with an oxidizing atmosphere may be employed. The atmosphere of the dung firing of the modern Pueblos was compared with that of the electric resistance furnace by using cylinders made of clay to which 5% of lampblack was added. After firing, the cylinders were cut through the middle and the thickness of the zone from which the lampblack was burned out gave a basis for the comparison of firing atmospheres. The dung firing was found to compare favorably with the conditions maintained in the electric resistance furnace. The loosely

[1]Some San Ildefonso potters believe that *guaco* produces a better black if it is aged at least a year before it is used (Guthe, 1925, p. 25); and aging has been suggested as a possible explanation of the differences in organic paints of various types of prehistoric Pueblo pottery (Amsden, Vol. I, p. 23). However, tests with freshly prepared and well aged *guaco* (kept over five years), in which all other conditions were kept constant, failed to show any difference. It seems very probable that the notion of the importance of aging originated from an attempt to explain a failure when the true cause could not be determined with certainty; and so the explanation may have become fixed, just as the idea that a cake batter should be stirred only in one direction, and similar culinary superstitions, persist among cooks.

laid chips and numerous open spaces give a good draft in the ordinary dung firing and organic pigments are exposed to oxidizing conditions during the greater part of the firing. It is entirely possible, however, that in the firing of certain prehistoric types a less completely oxidizing atmosphere was maintained. The two primary factors to be considered in explaining organic paints are therefore the firing conditions (temperature, time and atmosphere) and the properties of the clay upon which the paint is applied.

The surface texture of an organic paint is ordinarily quite different from that of a mineral paint. The solution of organic matter penetrates the paste without destroying the arrangement of clay particles, even though a coating of organic matter remains on the surface. Upon firing, the surface deposit is largely removed by oxidation, the adsorbed pigment imparts the color and the surface clay is left in its original condition. Thus if the vessel has been polished previously to painting, the polishing strokes will be uninterrupted by paint lines, which gives the impression that the vessel was polished after painting. This point has been proven experimentally. It was found difficult to polish the moist paint surface without smearing the lines; and the dried organic matter on clay becomes hard and resistant to burnishing, but paint applied on a highly polished surface has a luster comparable with that of the slip. This peculiarity of organic paint should be kept in mind in describing the workmanship of prehistoric types. It does not apply to mineral, particularly argillaceous, paints, for they can be, and certainly were sometimes, polished. Mineral paints are applied as a suspension rather than a solution; they, therefore, coat the surface and cover the clay. This difference between organic and mineral paints is clearly seen in thin section; the carbon paint does not stand up as a superficial layer but discolors the clay for some depth; whereas the mineral paint generally forms a distinct outer coating upon the vessel surface.

Minor peculiarities of the organic paint of certain types of Pueblo pottery may require experimentation before they can be explained. The blurred outline noticeable on certain Mesa Verde vessels, for example, may be due to any one of a number of causes; a paint of slightly different composition which diffused more readily, a more permeable paste, application of the paint on a moist surface, or redrawing a line with a thinner solution. Only trials with material similar to the original will show which factor, or what combination of factors, produced the effect. Another peculiarity is found occasionally on vessels which were exceptionally well fired and well oxidized; the painted surface takes on a distinctly brownish cast and the slip near it may also be discolored. A similar effect has been produced on certain clays with excess alkali when fired to the higher range of Pueblo temperatures. A minor cause of variation in depth of color is the thickness of the paint solution. Mixtures either half or double the strength used in the experiments described (29 parts of pigment to 71 parts of water) were paler in color, for with double strength, the solution was too thick to penetrate well, while with half strength there was insufficient coloring matter. When a line was painted twice with a half strength solution, however, a deeper color was obtained than with one application of normal strength solution because of more complete penetration.

Organic paints have been discussed at length because they illustrate the variety of problems which remain to be solved after the coloring matter has been identified and they also prove the importance of synthetic tests in this phase of the work.

Mineral no less than organic paints present a variety of problems. Quantitative analysis is particularly applicable to this group, not alone for comparative purposes but also to determine the nature of the binder and as an aid in locating the source of the material. The principal black mineral pigments of Pueblo pottery are either oxides of iron or manganese or a mixture of the two. In mixed pigments the ratio of ores may be of value for identification.

One of the interesting questions in connection with mineral paint is the nature of the binder. Finely ground iron oxide alone does not flux or sinter upon firing at temperatures within the Pueblo range. Paint of this type consequently remains in a powdery condition and is easily rubbed.[1] The ground mineral mixed only with water is also difficult to apply. Some modern Pueblo potters add *guaco* to the ore which gives it good spreading quality and also binds it when dry and before firing, thus making it easier to handle. Hawley has assumed that a vegetable paint was also used with all prehistoric iron paints and that the postulated silicate films supposed to be formed on the firing of organic paint also served as a binder for the mineral paint.[2] Evidently on the basis of this assumption the oxidation test for iron was called by this writer the "iron and carbon test," though it gives no indication whatsoever of the presence of carbon. The ferrocyanide test for iron is described as an alternative for the oxidation test to be used in doubtful cases, and in this connection the statement is made that if carbon is present it will be seen as minute black particles floating in the solution; also in doubtful tests for organic pigment the determination of carbon with an aspirator is suggested, but there is no assurance that actual tests for carbon were made for all the prehistoric types which have been classed as iron and carbon paints. Anyone who has used ground mineral paint both alone and mixed with plant extract will appreciate the advantage of the latter in consistency and even flow from the brush and will realize that this one advantage justifies its use, even though its function ceases there. However, not all modern Pueblo potters follow this practice. The women of Zia Pueblo at present prepare pigment from small oölitic iron manganese concretions which they find in the débris from a weathered stratum of Cretaceous sandstone six to eight miles from their village. Some potters use only the ground mineral, others mix it with ocher clay to improve its spreading qualities and permanence. Paint of the former type especially is not made permanent by firing, but the potters claim that when it is soaked in water (which is hard), it is fixed, and, as a matter of fact, the paint is not easily rubbed on vessels, which they show to substantiate this statement. This is a distinct

[1]The relative impermanence of iron ore alone is illustrated by the class of pigments commonly referred to as "fugitive reds" which are found particularly on Pueblo pottery from early horizons. It is probable, though still to be proven, that these paints differ from the later, permanent reds which replaced them in the ratio of ferric oxide to clay. Hematite relatively free from clay has no binder, is rubbed or washed from the vessel, and is readily attacked by acids. A ferruginous clay which has a high enough iron content to burn to a bright red is bound by the clay which is not easily soluble in acids.

[2]1929, pp. 736, 741-742.

problem in itself. It may be that the loose pigment is washed off or that with the evaporation of water some salts which act as a mechanical binder are deposited on the surface. The addition of clay, of course, tends to bind the pigment but the amount required gives the paint a distinct grayish cast. The practice of the Zia potters serves to emphasize the fact that the mixture of organic paint with mineral in prehistoric times requires proof. However, the absence of carbon in mineral paint will not necessarily show that it was not used, for in some instances it may have been so completely oxidized that only the mineral matter remained.

The evidence which has been presented regarding the relative inactivity of the ash in organic paint applies equally to the assumption that organic matter served as a binder for mineral paint after firing. Moreover, this theory has been checked experimentally. *Guaco* in various percentages has been added to Zuñi and Zia pigments and in no instance did it bind or increase the permanence of the mineral paint. It is possible that natural fluxes, as alkalies, or borax, occurred with the ores or were introduced into the mineral paint; and the fact that certain of the mineral paints are occasionally glazed or fused in places lends support to this theory. It is also interesting to note in this connection that the addition of an alkali such as sodium carbonate to mineral paint improves its consistency, so that use of a plant gum is entirely unnecessary. It is possible that some iron was reduced to the ferrous state, in which it would flux at a much lower temperature than in the ferric. Hawley describes the iron paints as "red iron oxide (Fe_2O_3), or yellow iron oxide ($2Fe_2O_3 2H_2O$), which burns to Fe_2O_3," and evidently thinks that magnetite would not be oxidized or ferric oxide reduced in firing.[1] But it has been demonstrated experimentally that the condition of the iron may be changed in firing and its original condition can only be proved by the discovery of the unfired pigment. Paint stones, mortars with paint adhering to them or unfired pottery, which may be found in excavations, would answer this question. Hematite heated in a reducing flame becomes magnetic while magnetite or ferrosoferric oxide loses its magnetism upon heating in the oxidizing flame. It is of interest, therefore, to learn whether iron paints are magnetic. Magnetic property is tested by scraping some of the paint free from the surface and determining whether it is attracted by a magnet.

The questions relating to mineral pigments, though of an entirely different order than those considered under organic paints, also require synthetic experiments and show the importance of firing conditions and physical and chemical changes in clay and pigment.

Determination of Firing Temperature

The temperatures attained in the firing of pottery in prehistoric times have long been a matter of speculation. Some idea of the possibilities can be obtained by measuring the temperatures used by primitive potters of the present day and by experimenting with various methods of simple, flame-exposed, non-kiln firing. For this purpose a reliable means of determining temperatures is required. The pyrometric cones used in commercial ceramic work are unsuitable because they are

[1] 1929, p. 736.

affected by reducing gases sometimes present in the firing atmosphere and also by length of heating as well as temperature—with a slow fire they will bend at a lower temperature than with a rapid fire. A thermoelectric pyrometer has proved to be the most accurate and convenient insturment for temperature measurement, both in the field and in the laboratory. A portable type is used with a "chromel-alumel" thermocouple. This instrument is based on the principle that two different metals in contact set up an electromotive force when heated, the current produced being directly proportional to temperature. The thermocouple, made of two wires—one of which is a nickel-chromium alloy and the other a nickel-aluminum alloy—fused at the ends but insulated for the remainder of their length and covered by a protecting tube, is placed at the point at which temperature is to be recorded. The free ends of the wires are connected with the binding posts of a potentiometer or pyrometer, which records the current in millivolts or is calibrated to read temperature directly. The simple tube of the thermocouple does not arouse the suspicions of the Indian, and temperatures are read at short and regular intervals so that a time-temperature curve of the firing can be plotted. If a porcelain protecting tube is used, it is necessary to calculate the lag which it produces; a silica protecting tube is more satisfactory because it introduces no appreciable lag and will not crack with sudden and extreme changes in temperature.[1]

Excavations have yielded no evidence as to the way in which the prehistoric Pueblo potter fired. Her modern descendant goes to our refuse heaps for tire rims, flattened springs, scraps of sheet iron and other odds and ends with which to make a grate and to cover the pots. Fuel, too, has changed, for the prehistoric potter did not have the cow or sheep dung now used by the Pueblos. In spite of these differences there is much to be learned from the modern potter, and experiments can be made with wood fuel to compare temperatures and results. Juniper wood furnishes the best fuel generally available in this region. It gives a much less smoky fire than either pine or piñon. Factors which determine temperature are rate of combustion and amount of heat lost through radiation; the rate of combustion is itself influenced by the kind and condition of fuel and by draft. Dung burns out very quickly because the combustible material is in a fine state of division. A wood fire will burn longer than one of dung if reasonably large pieces of wood (four to five inches in diameter) are used, and length of firing as well as maximum temperature affects the hardness of the vessel. Dung contains a much higher per cent of ash than wood,[2] and the ash left on the surface of dung chips acts as an insulator; radiation is thus reduced, but if fresh fuel is added on top of the old, less heat passes inward to the pottery. With the same fuel and method of firing, the highest temperatures can be attained when there is a strong wind giving a good draft. The potter, however, would avoid firing on a windy day because of the difficulty of controlling the fire, the danger of uneven heating and of suddenly chilling and cracking the vessels. With these conditions in mind, the question of the minimum and maximum temperatures used by

[1]For a discussion of principles and methods of high temperature measurement see Foote, Fairchild, and Harrison, 1921.

[2]From 14.8 to 29.2% of ash was found in cow dung—the variation being due to amount of dust collected in drying—and 0.92% of ash in seasoned juniper.

the primitive potter can partially be answered. The minimum temperature will be limited by the necessity of firing the clay sufficiently to produce a strong and durable vessel and will vary with the degree of refractoriness of the particular clay used. Many clays would disintegrate in water unless heated above 600° C. The lowest temperature so far recorded from the Pueblos is 625° C. This was at Santa Clara Pueblo in the firing of a large *tinajon* made from a non-refractory, red-burning, alluvial clay. The highest Pueblo firing temperature recorded to date is 940° C., which was attained by a Zia potter when firing forty small bowls on a windy day. The maximum temperature which has been obtained to date in experimental direct firing is 1020° C. This was with juniper fuel on a moderately quiet day, and maximum temperature was reached in thirty-eight minutes.

It is evident from the above firing records that the prehistoric Pueblo potter had a possible temperature range of at least 400° C. It becomes therefore a matter of considerable interest to compare the firing temperatures used for different wares and in different periods. Were some types of pottery intentionally fired higher than others? Is there evidence of improvement in firing as time advanced? Or were there simply low firings and high firings in every period, just as there must have been careless and careful craftsmen? These questions justify the effort to determine how vessels were fired. But this cannot be done as simply and directly as temperatures are measured, nor can as definite and exact results be expected. The problem becomes one of recognizing evidences of temperature in the condition of either the clay or the mineral inclusions. Geophysicists have devoted much time to the development of what has been called a "geologic thermometer," that is, a series of minerals which have two or more forms depending upon the temperature at which they crystallize and whose presence in rock, therefore, shows within certain limits the temperature of the original molten rock magma. It is possible that similarly a "ceramic thermometer" may be worked out when the changes produced in minerals by the particular kind of heat treatment received in primitive firing has been fully investigated. A few of the most promising temperature indicators have been studied.

The changes produced in minerals by heating are of two kinds: changes in crystal form and molecular arrangement—termed inversions—and changes in chemical composition, such as loss of water or carbon dioxide. Quartz furnishes a good illustration of inversion; at 572° C. ± 5° C. its crystal form is altered and it undergoes a 2% change in volume; at 870° C. it changes to tridymite, which in turn changes to cristobalite at 1470° C.[1] All four forms are identical in chemical composition, but their physical and optic properties differ because of molecular rearrangements. In view of the abundance and ubiquitous occurrence of quartz, these inversion points would be particularly useful temperature indicators in ceramic investigations were it not for the fact that they are reversible and often take place sluggishly and only under favorable conditions. Consequently, inversion might not occur with short, rapid firing and even if it did the quartz would in time reassume its original and more stable form. The change in volume which accompanies the low temperature inversion sometimes shatters the quartz, but this would not occur

[1]Wright and Larsen, 1909.

with the small grains found in pottery. Quartz has, therefore, been abandoned as a ceramic temperature indicator. All mineral inversions have not yet been exhaustively studied and it is possible that some may be found which will be useful to the ceramist, but it must be remembered that both low and high temperature forms may occur in nature and it is necessary to determine in some way the original state of the mineral—that in which it was introduced into the clay—before it can be used as a temperature indicator.

Hydrous minerals and the carbonates are the principal minerals whose composition is changed with moderate heating. Calcite is one of the commonest carbonates and has proved a useful temperature indicator. Fragments of calcite heated under certain conditions decompose and carbon dioxide is driven off, leaving calcium oxide which absorbs moisture to form calcium hydrate. The cycle may be completed if calcium hydrate unites with carbon dioxide of the atmosphere again to form calcium carbonate. But although the chemical composition of the calcite and this end product are identical, the two differ in appearance sufficiently to be easily distinguishable; calcite occurs in clear homogeneous fragments usually showing cleavages and acting as a unit optically, but after it has been calcined, hydrated and carbonated, it appears as aggregates of minute granules, lacking uniform orientation. Therefore, if particles of calcite are found in pottery, it is evident that the temperature at which calcination takes place was not reached in the original firing, but if there is free lime in the paste or if large calcined fragments occur, the temperature of calcination was exceeded. Calcination is sometimes shown by "popping" on the surface of the vessel. It is essential to record this condition since it is an important temperature indicator. The lime expands upon hydration and if the particle is large and near the surface of the vessel it will force off a flake. A little whitish material at the center of the rough and slightly conical area left by this fine spalling usually indicates the presence of lime, but in case there is any doubt the substance should be tested for calcium. If the calcite is in a fine state of division there will be no "popping" but minute whitish particles may sometimes be detected microscopically. These are so soft that they would have been disseminated when the clay was kneaded had they originally occurred in this state.[1]

[1]In the absence of visible particles which can be tested for calcium it is difficult to prove the presence of free lime in the paste. The determination of calcium hydroxide in the paste is based on an alkaline reaction with phenolphthalein followed by microchemical identification of lime as oxalate. If lime is found it may have been derived from calcium sulphate which has approximately the same solubility as calcium hydroxide and the pink color with phenolphthalein also is produced by other bases. The filtrate from the calcium oxalate should, therefore, be tested for sulphates. If sulphate is present in significant amount, it is necessary to make a quantitative determination of acids and bases in the water extract. Calcium bicarbonate is more soluble than calcium hydroxide but cannot occur with calcium hydroxide and an alkaline reaction with phenolphthalein shows its absence. Calcium carbonate gives a very faint alkaline reaction but only 0.0013 parts are taken in solution in cold water compared with 0.17 parts of calcium hydroxide.

If sherds are treated with hydrochloric acid when cleaned, the lime test is valueless. It may seem surprising that calcium should be present in the caustic state, but Mellor reports (1916, p. 332) that mortars in some ancient Roman buildings contain inner cores of calcium hydroxide after an exposure of 2000 years. Its existence in pottery is still to be proven. Some sherds showing clear evidence of "popping" gave no test for free lime, probably because the hydroxide had been reconverted to carbonate by exposure to the air.

The calcination of calcium carbonate does not commence and go to completion at a given temperature, as might be supposed from some published statements.[1] When calcium carbonate is heated the pressure of carbon dioxide in the atmosphere and in the kiln gases tends to counteract dissociation. Calcium carbonate is stable at ordinary temperatures because the pressure of the atmospheric carbon dioxide is greater than the dissociation pressure but they become equal at a temperature near 600° C. and at 898° C. the dissociation pressure equals the total atmospheric pressure.[2] If therefore, calcium carbonate is heated long enough at a temperature just above 600° C. all of the carbon dioxide will be liberated, while the change will be almost immediate at the "dissociation temperature." It has been found that impurities lower the dissociation temperature; 888° C. having been recorded for an impure limestone. In the present study, samples of Iceland spar, a very pure form of calcite, were heated in an electric resistance furnace with accurate temperature control to gain some idea of the rate of dissociation within the temperature range and with the rate of heat increase commonly obtained in primitive firing. The surface of crystals held at 700° C. for five minutes became milky from dissociation and films varying from 0.1 and 0.3 mm. in thickness were formed when this temperature was held for an hour; the same depth of calcination was obtained with ten minutes heating at 800° C.; heated for ten minutes at 850° C. the film was 0.4 mm. and for three minutes at 900° 0.6 mm. in thickness. It is evident that both time and temperature must be considered. A third factor which enters is the amount of carbon dioxide in the kiln atmosphere. The experiments with Iceland spar were made under normal atmospheric conditions, but in primitive firing, excess carbon dioxide from the combustion of fuel is present in the atmosphere surrounding the pots which retards the rate of calcination. Particles of calcite were fired both with dung and with wood fuel to compare the rate of decomposition with that obtained in the electric resistance furnace. The results indicated only a slight and scarcely measurable decrease in rate of calcination.

Therefore, instead of marking a specific temperature, calcite indicates a certain temperature range. If large fragments show no evidence of calcination and if undisturbed faces are fresh and clear, the firing temperature certainly could not have reached 800° C. and probably was not held at 700° C. for any length of time.[3] If, on the other hand, large fragments (1 mm. in diameter for example) have produced "popping," it is probable that the fire was held at 800° C. for at least half an hour, or that a temperature of 850° C. or more was attained with rapid heating. In the discussion of the Pecos material, the condition of the calcite has been mentioned specifically rather than the probable temperature indicated, and it will be convenient

[1]Speiser, 1933, p. 283: "... calcium carbonate does not begin to decompose into calcium oxide and carbon dioxide until a temperature of 1537° F. has been reached." (1537° F. = 836° C.).

[2]Wilson, 1927, pp. 154-155.

[3]Caution must be exercised in judging the degree of calcination from the appearance of fragments seen in a fresh break because the calcined layer tends to separate and break away from the uncalcined part of the crystal, and this is particularly likely to happen when the sherd is fractured. With thin sections and high magnification it should be possible to determine the extent of calcination from an examination of the contact zone of crystal and clay.

simply to remember that the presence of calcite shows that the heat treatment was low in terms of Pueblo firing and that definitely calcined material indicates a medium or high range, though it cannot be determined how far the temperature of calcination was exceeded.

The discussion of calcite as a thermal indicator is based largely on microscopic observation, but the same evidence has been studied by means of chemical analysis, the presence of calcium carbonate being inferred from carbon dioxide obtained in the analysis.[1] Carbon dioxide liberated upon digestion with hydrochloric acid would be derived from carbonates but that obtained from ignition of the sample might come from either the decomposition of calcium carbonate or the oxidation of carbon in the paste, and, as both reactions take place within the same temperature range, carbon dioxide from these two sources could not be distinguished. The chemical method used alone is of uncertain value because the condition and source of the carbonate of lime is not determined. Sherds lying in the earth are sometimes impregnated with calcium carbonate from soil water and this fact would completely vitiate results of the chemical method. A secondary deposit is easily distinguishable from calcite with the petrographic microscope, and an additional advantage of the microscope, as compared with chemical analysis, is the fact that it shows the extent of decomposition, whereas with the chemical method the presence of a considerable amount of carbon dioxide may result either from a large amount of carbonate partially decomposed or from a smaller quantity unaffected in firing.

Other minerals which give promise of indicating firing temperatures may be briefly mentioned. Some varieties of chlorite, hydrous silicates of aluminum, magnesium and ferrous iron, change in color from green to brown when heated to 650° C. They resemble biotite superficially after firing. As there are a number of varieties of chlorite and closely related hydrous minerals additional experiments should be made. Muscovite, the potash mica, is also dehydrated upon heating and becomes gray and opaque. This change is familiar to everyone, for it takes place when the mica or isinglass windows of a range become opaque and somewhat opalescent. Repeated thermal experiments have shown that the temperature of dehydration of mica is somewhat variable, taking place between 900° and 950° C. with rapid firing—samples being brought to temperature in from thirty to forty minutes and held five minutes. Muscovite, therefore, furnishes another critical point in our ceramic thermometer. Small flakes of mica of uncertain composition, leached biotite for example, are not uncommon in pottery and, since they may not give as clear evidence of dehydration as muscovite, sherds should be reheated to the temperature in question and the condition of the mica then compared with the original. Thin sections are not generally necessary for this purpose because flakes can be picked out of the sherds with the aid of a binocular microscope and examined in refractive liquids. Evidence of dehydration of mica may sometimes be observed megascopically, for the expansion of plates just beneath the surface tends to force off thin flakes of clay, consequently mica which appears to be lying on the surface is seen upon careful inspection to be slightly depressed and the paste bounding it is irregular and

[1]Speiser, 1933, p. 283.

fractured. The change in chlorite and mica is due to dehydration, the rate of which is affected by time and temperature of firing but not by the character of the atmosphere.

The minerals discussed might all be found as natural inclusions or as part of the tempering material in pottery, since they are of common occurrence. But the clay minerals themselves of which the clay base is largely composed also undergo interesting and significant changes upon firing. The water of crystallization is first driven off and more complex changes, including the dissociation of the aluminum silicate, take place at higher temperatures. Optical properties are affected when the crystalline structure is broken down; the mineral ceases to be doubly refracting and acts upon light in the same way as an amorphous substance. Consequently, if the clay material is birefringent, and even though individual crystalline particles cannot be distinguished, it is known that the clay has not been heated high enough to destroy its normal molecular arrangement. The refractive index also changes upon heating, but instead of a single complete change, values vary with temperature but not uniformly or without interruption. Specific reference data for the use of clay minerals as temperature indicators could be given if the body clays were pure and unmixed with other substances and had the thermal behavior of the clay minerals been fully investigated. But practically all pottery clays are of mixed and uncertain composition and few studies of thermal changes have been made. Hence experiments must be made with each particular paste being investigated.[1] If the clay base of a sherd is isotropic, it will not be possible to tell whether this was its original condition or whether a crystalline structure has been broken down in the firing. But if the paste is birefringent, it is necessary only to make a few accurately controlled firings to determine at what temperature it becomes isotropic. This sets an upper limit above which it could not originally have been fired. The temperature at which this change occurs will vary greatly depending upon the particular clay mineral and impurities present. Studies made in connection with the Pecos investigation indicate that kaolinite in kaolin becomes isotropic at a considerably higher temperature than montmorillonite in bentonite, as might be expected from the difference in their relative refractoriness. Changes in the refractive indices of clay are less promising as temperature indicators than loss of birefringence because of their variability and complexity. If the raw clay from which a vessel was made is available, a study of its thermal behavior and comparison of refractive indices may offer some evidence. The rare discovery in excavations of potters' caches may establish the use of a particular clay.

Physical properties of the paste and its fusion point have sometimes been used as temperature indicators. The density of the paste is continually changing during firing; it decreases and the paste becomes more open when dehydrated but at some temperature above the point at which dehydration is completed, density commences to increase and this process continues until a condition of complete vitrification is

[1]For data on themal behavior of clay see

Rhode, 1927, pp. 383-401, 414-415, 434-435, 452-454, 470-471.
Kraner, 1924, pp. 726-734.

reached. The accompanying change in volume can be measured as linear shrinkage, and porosity likewise indicates relative density. Therefore, after refiring a sherd to given temperatures these two properties can be measured and their values compared with the original. A distinct difference may be shown if the firing temperature has been exceeded, but in some pastes only slight changes occur over a considerable temperature range. The presence of unoxidized substances, such as carbon in the paste, will introduce an error. The softening and fusing point of clay or its pyrometric cone equivalent is determined by forming small tetrahedrons of clay corresponding in size and shape to the pyrometric cones of commercial practice (7 mm. along the edge of the base and 30 mm. high).[1] These are set in a base at an angle of 82° to the horizontal and fired. The softening point is the temperature at which the tip commences to bend and the fusion point the temperature at which it touches the base. This test not only shows fusion point but also, by the time required for the cone to bend, records the temperature range between initial and complete vitrification. In other words, it serves to distinguish between clays which vitrify suddenly and are subject to distortion if the vitrification point is reached and those which vitrify more slowly and so may safely be carried to this point. The fusion point of the paste of a sherd has been used to determine an upper limit which must exceed the original firing temperature if the sherd shows no sign of vitrification.[2] The value of the test is doubtful because texture as well as composition affect vitrification. The fusion point of two clays having the same chemical composition will differ with grain size for vitrification is promoted by fineness of grain and the close contact of particles. A consideration of this fact will show that such a test cannot be a reliable indicator of the fusion point of the paste, for when the sherd is ground the clay substance probably will not be brought to its original fineness, whereas medium or coarse temper, if present, will be reduced to a much finer condition, and two unknowns are thus introduced to vitiate results.

Considering all factors, therefore, changes in minerals detected optically are the most reliable temperature indicators. These mineral indicators may be compared to the pyrometric cone because they are affected by length of heating as well as temperature and reflect total heat treatment but do not specifically record maximum temperature. Even with these limitations they furnish important evidence and are especially valuable if two or more can be found in the same specimen.

Description of Physical Properties

The adequate description of certain ceramic properties is difficult because we lack accepted standards of comparison and methods of measurement. Consequently, there is a current belief among archaeologists that many of the characteristics of pottery cannot satisfactorily be defined or described, although they are recognized with certainty by the experienced individual. Forms are accurately recorded by specified measurements, illustration, and the calculation of certain ratios; a satisfactory nomenclature of vessel forms is becoming established. Design

[1] *Journ. Am. Ceram. Soc.*, Vol. XI, No. 6, p. 452. [2] Speiser, 1933, pp. 282-3.

likewise has been treated analytically. But properties such as color, texture, hardness, density and porosity, which are also significant, are described in relative terms and with reference to subjective standards; such descriptions are of limited value or even confusing. The statement that a paste is gray, fine, hard, well kneaded or levigated means very little unless one is familiar with the range of pastes which form the basis of judgment. Such terms as well kneaded or levigated are particularly objectionable, since they designate processes in the preparation of clay which cannot be proven from observation of the paste. The physical properties of the vessel are important because they affect its appearance, durability and usefulness; and since they are determined by the materials used and the method of firing, they throw light on composition and technique. The principal physical properties of pottery have been defined, and standards of description together with methods of measurement have been adopted in the field of commercial ceramics.[1] Many of these can be adapted to archaeological purposes and a few, which measure properties of particular significance, have been tested and applied in the present study as well as certain standards which have found acceptance in other fields.

Color, being one of the most striking properties of pottery, has received considerable attention in published descriptions and has been much used as a classificational criterion. The color of clays when fired influences the aesthetic value of pottery, and since color is determined by the composition of the clay, together with firing temperature and atmosphere, it records evidence of these factors. Like the patterns of finger prints, its variations are infinite, but its value in recording distinctions is proportional to the accuracy of color designation. The vagueness and limitations of the color vocabulary of the average individual are so well recognized, that it hardly seems necessary to urge the need of a standard color scale and nomenclature. But it may be argued that the range of color variations of a single clay fired under different conditions is so great that exact color description is impracticable, and such general terms as red, brown, gray, buff, etc. are sufficient for the needs of the archaeologist. This objection simply raises the question whether we shall take advantage of the innumerable and often subtle variations in pottery to build up a body of significant data, or allow ourselves to become confused and discouraged in the attempt to understand the evidence before us. A standard for color description is essential both in comparative studies of pottery types and for analysis of the color range of clays, pigments, and glazes with varying firing conditions.

Colors are most easily defined by comparison with a recognized standard color scale. A number of these have been published, but *Color Standards and Color Nomenclature* by Robert Ridgway[2] is the most widely used by scientists. It has been the standard of reference for zoölogists and botanists for over two decades and more recently has been used for ceramic descriptions both in archaeological studies and in commercial work.[3] In the present investigation it has proved entirely satisfactory in range, distribution, grading and arrangement of colors, and a copy used in this

[1]See *Journ. Am. Ceram. Soc.*, Vol. XI, No. 6, for standard definitions and tests adopted by the American Ceramic Society.

[2]Ridgway, 1912. [3]Bradfield, 1931, pp. 30-39. Dietrich, 1928, pp. 248-252.

work for six years shows no fading or change in colors. The fact that it has become a well established standard through its general acceptance by scientists is also in its favor.

Ridgway's arrangement of color is logical and convenient. The key to the system is the series of thirty-six pure colors—the spectrum colors and intermediate hues—which are arranged horizontally across the center of a series of twelve plates. In the column above each color are three of its tints, made by adding given percentages of white to the pure color, and below are three shades formed by the addition of black. Five succeeding sets of plates repeat the colors of the first twelve with increasing amounts of neutral gray. The hues are designated by odd numerals, tints by the letters *b*, *d* and *f*, shades by the letters *i*, *k* and *m* and the five series of grayed colors or values by the symbols ′ to ′′′′′. The use of odd numbers and alternate letters permits the designation of intermediate colors and so increases their number within the scale. The three color variables, indicated by number, letter and prime in the Ridgway system, express fundamental properties of color. Hue or position of the color in the spectrum scale is determined by the wave length of light; the intensity of color, by which light colors are distinguished from dark or tints from shades, is dependent upon the amplitude of the light wave, and the grayed colors or values are a measure of the relative purity of one wave length as separated from all others. Familiarity with this system enables one to tell at once from the number-letter-prime symbol, the position of a color in the spectrum scale, whether it is a tint or a shade and the degree to which it has been grayed. For example, 9′i is orange red-orange (20% red and 80% orange) with 45% black and the whole modified by 32% neutral gray. Outside of the grays the colors of fired clays fall principally between Ridgway's 5 (orange orange-red) and 23 (yellow), and unmodified colors occur only in the glazes. In the common use of color names, Ridgway's 1 to 5 would be red, 9 to 15 orange, and 17 to 23, yellow; the *f* tones are very light or pale, and the *k* tones in the series of hues from 7 to 17 would be classed as browns, the *m* tones as dark browns. The brightest or clearest clay colors are one prime; three primes are dull and the five primes are grays. Ridgway's names, as well as the symbols, have been used in the present study, but it is believed that the symbols will prove more satisfactory, once the system is known. In this report color names not capitalized are used in a general sense, as in reference to a color range, and the Ridgway system has seldom been applied to colors observed microscopically because of the difficulty of making accurate readings.

Some experience and certain precautions are required for accurate color reading, and at the start the exactness of one's color matching should be checked by individuals with experience and training in this line. It is important to hold the object being matched in the same plane as the color plate; the angle at which light strikes the plate and is reflected to the eye should be approximately equal. A north light is preferable, and readings should never be made in direct sunlight. The object being matched should be held as close to the standard color as possible, and in matching the paste color of sherds it will be found convenient to break off a small flake which can be held against the plate. When making a reading it is also advisable to block all colors on the plate except the one being compared and if a polychrome

sherd or one combining distinct colors is being matched, a mask should also be used on the specimen. Frequent mottling of the surface, as well as differences in texture and luster may be confusing and increase the difficulty of matching. It is sometimes helpful to regard the colors at arm's length or with partly closed lids. Colors not matched in the Ridgway standard can always be accurately classified by the system and thus satisfactorily designated.[1]

[1]Since the above was written the desirability of a standard of color description has been ably discussed by March (1934, pp. 23-30). March has used *A Dictionary of Color* by A. Maerz and M. Rea Paul in preference to Ridgway's Standard and gives three reasons for his choice, namely, that the number of colors given by Ridgway is relatively small (1,115 as compared with 7,000 in the *Dictionary of Color*), that the Ridgway plates are more subject to light and must be handled with care, and finally that Ridgway's nomenclature is faulty. March tested both works in matching the colors of Chinese porcelains. A comparison of the two systems was subsequently made in the study of the Pecos material, and since a wide range of clays, subjected to the varying temperatures and atmospheres obtaining in direct firing, are included in this material, it may be considered reasonably representative of primitive pottery in general. In these tests, Ridgway was found to be more useful as a standard and the objections pointed out by March proved no serious detriment.

The value of a color scale cannot be judged simply by the number of colors given, we are concerned also with the completeness and uniformity with which the entire color range is represented; a large number of colors may simply mean that fine variations are given in certain ranges only and wide gaps left in others. In respect to range and uniformity of distribution Ridgway has been found more satisfactory than the *Dictionary of Color*. The change from hue to hue and tint to tint in the latter is very slight, actually much closer than is required by the student of primitive ceramics, for a number of colors would have to be named in most designations because of the slight variations which generally occur. It is even questionable whether the majority of individuals would always match to the same color in certain ranges of this system. On the other hand, the difference between values and in some cases between tints and hues is much greater. Ridgway's colors are more evenly graded and cover the total color range more completely. The limitations of *A Dictionary of Color* are noticed particularly when matching the deep browns. Shades in the range of Ridgway's 5′m to 17′m are not represented. These colors are important to the student of primitive ceramics. The grays in the *Dictionary of Color* are generally less neutral than Ridgway's and the plates of grays in the latter greatly facilitate matching. In using Ridgway one is not actually limited to the colors illustrated, since allowance is made in the system for the designation of colors intermediate in hue or intensity, and there is never any question as to the position of a given color; it can be accurately defined by reference to the colors illustrated. Interpolations are not as easily made in the *Dictionary of Color* because of an entirely different and unusual system of arrangement.

The publishers of Ridgway's Standard warn against unnecessary exposure of the plates to light. However, permanence of the colors is best tested by comparing volumes which have received long and constant use with new ones. Such comparisons have shown that Ridgway is reliable in this respect.

The criticism of Ridgway's nomenclature is not without foundation; however, the fact that some of the adjectives are confusing, that priority was not invariably recognized and that commercial names are included does not seriously impair the value of the standard. Symbols are here used in preference to names, since hue, value and intensity of the color are definitely indicated by the symbol, which is a decided advantage. In *A Dictionary of Color* the plate number, file letter and rank number designate the color but bear no logical relation to its position in the color scale and reference must, therefore, always be made to the work to visualize the color.

There are two principal advantages in the Ridgway system as compared with that of Maerz and Paul which fully justify its retention as the standard of comparison in ceramic studies. The composition of colors is fully defined and the range is uniformly represented. The Maerz and Paul volume, on the other hand, is, as its name indicates, a dictionary; it includes the largest number of colors available in any work of this kind, but the colors are not defined nor uniformly distributed. In the second place Ridgway's arrangement and designation of color is logical and convenient and automatically trains the user in color reading, while the only guide in matching colors in the *Dictionary of Color* is spectral arrangement.

Hardness has been defined as resistance to abrasion. Its importance to the potter is well illustrated by differences in slips. In a random lot of sherds there will be some which are as smooth surfaced and fine as when first made, and others having slips which are rough and, in places, completely worn away. The hardness of pottery is affected principally by two factors, refractoriness of clay and firing treatment, although paste texture also influences vitrification point and consequent hardness. Therefore, conclusions regarding either firing temperature or quality of the paste cannot be drawn from the determination of this property alone. The hardness of pottery is difficult to measure, particularly since pastes are non-homogeneous. The bond is most often determined by this test. Estimates of hardness are sometimes made by scratching the surface with a steel point or fracturing the sherd with pliers. In the American Ceramic Society's discussion of standards it is suggested that this property be tested by "noting the relative hardness of trials as compared with steel."[1] Since comparatively few wares in the archaeological field are as hard as or harder than steel, and estimates of the relative ease of scratching will vary, such a test does not meet the archaeologist's requirements. In order to eliminate personal judgment as far as possible, a number of standards of reference within the range represented by pottery is necessary and such a series is supplied by the minerals of Mohs' scale of hardness, which is commonly used by geologists. A high degree of accuracy cannot be claimed for this method and the scale is not evenly divided. However, absolute accuracy in the determination of hardness is not required by the archaeologist, but rather a standard reference by which four or five degrees of hardness within the ceramic range can uniformly and consistently be recorded. This requirement is met by Mohs' scale. The minerals most used are calcite, fluorite, apatite, orthoclase and quartz, which number three to seven in the scale.

A paste which is scratched by one mineral but scratches the one next lower in the scale is recorded as plus or minus the number of the nearer mineral, or if it is approximately midway between two minerals, it is indicated by adding half to the number of the softer mineral. As hard inclusions in the paste influence judgment, the coarsely tempered, friable pastes of culinary wares will be found most difficult to test. A surface which has been compacted by smoothing and polishing will be harder than the paste; determination of the latter should, therefore, be made on an unpolished surface or on a fractured edge which has been smoothed. A good point should be kept on the mineral, a relatively uniform pressure applied and care exercised to distinguish a scratch from the streak left by a mineral rubbed on a harder surface. If one proceeds from the harder to the softer minerals in testing, unnecessary wear of the soft minerals will be avoided.[2]

[1] *Journ. Am. Ceram. Soc.*, Vol. XI, No. 6, p. 457.

[2] Since the above was written, the adoption of Mohs' scale in ceramic studies has been recommended by March (1934, pp. 17-22). He has also suggested the introduction of additional minerals to form half steps in Mohs' scale. These have not been used in the Pecos study as the limitations in the accuracy of the methods do not seem to justify small subdivisions of the scale. The reliability of chabazite to measure a hardness of 4.5 is particularly questionable, since its hardness varies from 4 to 5 (Dana, 1892, p. 590). March states (p. 21) that minerals from 2 to 4.5 inclusive are " . . . adequate to meet the needs of archaeologists working in the American field, for extensive experiments in the Ceramic Repository in the Museum of Anthropology have revealed nothing harder than 4.5." Pastes harder than 4.5 however, have been found among Pueblo types, and the archaeologist should be supplied with the minerals of Mohs' scale up to and including quartz.

Strength. The difference in thickness of sherds and their curvature have been obstacles in measuring the strength of pottery. Moreover, the significance of the data has been questioned because of the considerable variation in this property which naturally results from the uncertainty of primitive methods; overlapping of types is to be expected, and possibly only slight differences will be found in the average strength of the majority of types. But this supposition should be put to test, and, furthermore, if we are to understand the materials with which we deal, the strength of clays must be determined and the effect of various kinds and amounts of tempering materials studied.

Different methods of measuring transverse breaking strength have been tested by applying them both to sherds and to specially prepared test pieces. Experiments were first made with a fracture machine employing a lever, but an apparatus in which weight is applied directly was found more accurate and reliable. Sherds are cut with a carborundum wheel $\frac{5}{32}$ of an inch in thickness and 7 inches in diameter having a speed of 3500 revolutions per minute. The pieces, approximately $1\frac{1}{2}$ inch wide by $1\frac{1}{2}$ inches long, rest on two knife edges set 1 inch apart. Pressure is applied through an upper knife edge by turning, at a uniform rate, the wheel below the dynamometer. The breaking weight is recorded directly on the dial of the dynamometer. To calculate the transverse breaking strength of the sherd in pounds per square inch the formula for modulus of rupture is used:

$$R = \frac{3Pl}{2bd^2}$$

In which:

R = modulus of rupture in pounds per square inch
P = breaking load in pounds
l = distance between supporting knife edges in inches
b = breadth of test piece in inches
d = depth or thickness of test piece in inches

Since the distance between the supporting knife edges is constant and unity, the numerator of the formula is simplified to 3P, and if the test sherd is cut $\frac{1}{2}$ inch in width the denominator is reduced to d^2; it is then only necessary to record the breaking load and take a micrometer measurement of the thickness of the piece.[1] The American Ceramic Society, in describing this test, specifies that a minimum of ten specimens of each type be broken, any varying more than 15% from the average discarded and if more than two are discarded the clay retested.[2] This applies to clay tests prepared and fired under identical conditions. Sherds containing a variable amount and grade of temper and having been fired to different temperatures will differ more than 15% from the average. But these normal variations must be dis-

[1]It was necessary to follow the English system in building the fracture machine because the dynamometer reads in pounds. But it has been deemed advisable to adhere consistently to the metric system throughout this report and modulus of rupture calculated in pounds per square inch has therefore been converted to kilograms per square centimeter by using the factor 0.07.

[2]*Journ. Am. Ceram. Soc.*, Vol. XI, No. 6; Tentative test methods, p. 461.

tinguished from those caused by flaws, therefore, in the Pecos study ten sherds of a type were tested and those which varied more than 15% from the average retested and the results included only when the breaking load was consistent.

The two most obvious factors which might vitiate the results of such a test when applied to pottery are curvature and differences in thickness, the latter factor being considered because surfaces compacted by polishing bear a different ratio to the normal paste in thick sherds than in thin sherds. Experiments were, therefore, made to test the applicability of the method to sherds, over a hundred test pieces being prepared for the purpose. In studying the effect of variation in thickness five sets of test pieces, ranging from 3.8 to 8.9 mm. in thickness, with differences of 1.25 mm. between sets, were used. This practically covers the range found in vessel walls. The test pieces were identical in composition, highly polished on one side and heated to temperatures obtaining in Pueblo firing. When fractured, the average of each set was found to vary less than 15% from the average of all five sets, and the character of variations showed that the factor of thickness is negligible in effect. To determine the error due to curvature, test pieces were formed with a curve 7.6 cm. in radius, which is greater than need ever be used in testing sherds, since the majority of bowls exceed 15.0 cm. in diameter, and the curvature at the base is frequently less than on the sides. The curved test pieces were divided into two groups, one of which was fractured with concave side up and the other with concave side down. These were compared with flat test pieces, all three sets having been made under accurately controlled conditions and differing only in shape. The curved pieces differed in strength by 5% from the flat pieces. The fact that the curved test pieces did not show the increased strength which would be expected is perhaps explained by the manner in which they are supported, since the strength of an arch results when it is supported at the ends. In any event the error introduced by curvature is so slight that it may be disregarded.

Flaws, often so small as to be unnoticed, are sometimes a more important cause of variation than either of the factors discussed. They are, of course, more common in sherds than in prepared test pieces and fractured surfaces should always be examined for evidences of lamination. The error introduced by flaws is usually corrected when sherds which vary more than 15% from the average and do not give a consistent second test are discarded. It is also important for the test pieces to rest evenly and squarely on the supporting knife edges. The distance between supports influences the accuracy of the test, and the American Ceramic Society recommends a 12.5 cm. span for a test piece having a 2.5 cm. square cross section.[1] A span of 2.54 cm. for test pieces which average 0.8 sq. cm. in cross section has given consistent results and it is desirable to reduce the size of the test piece as much as possible without sacrificing accuracy.

The strength of pastes can be compared by means of this determination of modulus of rupture, because the breaking load for a section one centimeter square is always calculated. It is also interesting to know the strength of types with their given thickness of wall; to learn, for example, whether thicker walls were made to

[1] *Journ. Am. Ceram. Soc.*, Vol. XI, No. 6, p. 460.

compensate for weaker pastes. This test is very simply made with the same fracture machine by merely cutting from sherds pieces of uniform width and measuring the breaking load. In the present study 2.5 cm. proved a convenient width and the average of ten pieces was considered representative.

The Pecos study illustrates the differences in strength and modulus of rupture found in a group of primitive wares, though very much stronger types are found in other parts of the Pueblo area. The range in strength of a paste is, as might be expected, often greater than the difference between the averages of types; nevertheless, some significant results were obtained and the method has been particularly useful in the study of clays and the effect of temper.

Porosity is an important property of pottery, for it determines its degree of permeability to liquids and influences its strength. An accurate determination of porosity furnishes the most satisfactory basis for comparing the density of pastes and gives some indication of the degree of vitrification which has taken place. It has sometimes been judged in the field by noting the length of time required for a drop of water to soak into the sherd. This is not only a very rough test but may actually be misleading, for the rate of absorption is not controlled by the amount of pore space alone. The size and shape of the pores which determine the capillarity, and the relative compactness of the surface produced when the vessel was smoothed or polished are both important factors. Experiments with sherds, whose porosity had been accurately determined, have shown that the more porous sherds sometimes absorb water more slowly than the less porous. Consequently, the rate of absorption cannot be considered a test of porosity and this property is best determined in the laboratory. The method which has been used in the present study is based on that adopted by the American Ceramic Society.[1] Types of Mimbres pottery have been tested by this method.[2] Porosity, reported as percentage, is calculated from the amount of water absorbed considered in terms of exterior volume, the following formula being used:

$$P = \frac{Sf - Wf}{Vf} \times 100$$

in which:

P = per cent apparent porosity
Sf = weight of saturated test piece in grams
Wf = weight of dry test piece in grams
Vf = volume of test piece in cubic centimeters

Sherds are dried to constant weight at 110° C. and cooled in a dessicator before taking the dry weight. They are boiled in distilled water for three hours and cooled in water to obtain complete saturation. A damp sponge takes off excess moisture without drawing it from the pores and the weighing is made as rapidly as possible to avoid loss of water from evaporation. The volume is determined in an overflow volumeter of Schurecht's design.[3] It is, of course, important to clean sherds thor-

[1] *Journ. Am. Ceram. Soc.*, Vol. XI, No. 6, p. 456.
[2] Bradfield, 1931, pp. 34-38.
[3] *Journ. Am. Ceram. Soc.*, Vol. XI, No. 6, p. 493.

oughly before testing and first to remove loose or projecting particles which might be rubbed off during the test. It is advisable to place a screen in the bottom of the vessel in which the sherds are boiled to avoid unnecessary agitation from the formation of bubbles beneath them. Some soluble salts may be lost in boiling but not in amount sufficient to affect seriously the accuracy of the test.

This test measures only partial porosity referred to as *apparent porosity*, because water does not penetrate the sealed pores and only the volume of the open pores is calculated; however, determinations of both apparent and total porosity have shown that in low-fired pottery, sealed pores either do not occur or form a very small percentage of the total pore space. For our purpose, therefore, apparent porosity closely approximates true or total porosity.

If a volumeter is not available absorption can be reported instead of porosity; that is the water absorbed is considered in terms of the dry weight of the specimen instead of its volume.[1]

While it may be found that the porosity of many types of Pueblo pottery averages between 20 and 30% and that sherds of a single paste may differ from 5 to 10%, types which fall below or above the average are none the less interesting and significant and the test is fully justified.

Standards of Pottery Description for the Field Worker

Field workers have been accustomed to describe technological features of pottery, as well as to classify and name types, on the basis of megascopic examination alone. It should not be the part of the ceramic specialist to discourage these observations, but rather to lend whatever assistance is within his power. The advantages of exact methods of analysis and the significance of technological data have conclusively been demonstrated, but the amount of material which will yearly be studied and reported upon far exceeds the facilities for microscopic examination. It is important therefore clearly to distinguish between those aspects of the subject which must be left to the specialist and the tests and observations which it is practicable for the general archaeologist, without special equipment or analytical experience, to undertake. The necessity for specific, impersonal standards of description which can be applied by the field worker is generally recognized, but if megascopic classification is accurately to record facts there must be at the start a candid acknowledgment of the limitations of megascopic identification.

Many archaeologists have demonstrated a reliable pottery sense, that is they recognize at once and without conscious analysis the likenesses and differences between types, but too often the basis of judgment is not scrutinized and as a result the idea that many ceramic properties can readily be recognized but cannot be described has taken deep root. Insistance upon adequate description will of necessity require more analytical and systematic examination than has hitherto been customary. Reviewing the features of pottery—paste, surface treatment, form, and decoration—usually selected for purposes of classification, it hardly need be pointed out that form and decoration simply require systematic, accurate observation and

[1] *Journ. Am. Ceram. Soc.*, Vol. XI, No. 6, p. 457.

measurement, while paste and technological features in general can only be described superficially or incompletely by visual inspection alone. It is only logical therefore that design and form should be emphasized in megascopic work and should form the primary criteria for classification. But as long as paste, surface finish, and nature of the pigment contribute to the impression upon which the field worker bases his classification, they must be described. A few suggestions are accordingly made here in the hope that they may contribute to the general effort to systematize methods of description and classification.

The paste is difficult to describe both because of its fineness and the invisibility of important features and because of the continuous intergradation of properties. The differentiations which can be made do not depend alone upon the power of the hand lens used, because the keenness of vision, training and knowledge of the observer play no small part in what he sees. Therefore due allowance must be made when it is said that this or that can or cannot be recognized. The characteristics of the paste which can profitably be considered by the field archaeologist are color, nature of inclusions, texture and hardness.

Color should be defined by reference to a standard (see p. 430). It is important that the description include the typical color, the color range and exceptional colors. The relative uniformity of color from surface to surface of a paste as viewed in freshly fractured section should also be recorded. The width of cores in relation to margins and the thickness of the inner as compared with the outer margin may sometimes be characteristic.

The field worker frequently attempts to identify temper or inclusions with the aid of a hand lens, but a review of southwestern archaeological literature proves that many of these identifications are incorrect. The folly of guesswork is realized when one stops to consider that some of these classifications were made by men whose vision was keener and knowledge and training broader than those of the majority of workers. The writer, who has exceptionally good vision, has during the last four years, constantly checked megascopic identification by petrographic examination with the resultant conviction that it is generally inadvisable to attempt to identify temper megascopically or with a low power hand lens. It is far better to describe in specific terms the appearance of the inclusions than to add to the accumulated fallacies of the past and their resultant confusion by uncertain identification. At best only the coarser inclusions can be seen and there are many possibilities for error in the identification of these; for example, lumps of clay in a carelessly prepared paste may look like sherd temper, fractures of feldspathic rock are often indistinguishable from fragments of whitish paste sherd, black sherd fragments may be confused with shale, and finally when temper is too fine for megascopic identification the paste may erroneously be classed as sand tempered on the basis of stray coarse grains which are merely accidental inclusions. In describing the appearance of inclusions the following characteristics should be noted: color, luster, degree of transparency, and shape—whether granular or platy, angular, rounded, or irregular. Even accidental inclusions may be characteristic of a paste, as lumps of unmixed clay or dull black rings surrounding pores which are caused by carbonaceous matter.

Our visual impression of texture is influenced principally by the grain size and amount of temper. This conclusion has been reached only after comparing specimens which were prepared in the laboratory with known differences in size, amount, shape and kind of temper. It was found that samples containing the same amount of aeolian sand, ground potsherd, ground rock and ground mica schist, all of which has been screened to obtain identical grain size, were indistinguishable except for the sand which appeared slightly finer and less ragged in texture; but even this difference was barely noticeable and would not ordinarily be recognized. Grinding mica schist did not effectively separate the plates and consequently the distinctive laminated structure was not produced. When grain size only was varied, using the standards suggested (see p. 410), the grades from fine to very coarse were distinguishable with the unaided eye and seen clearly with a 10-power lens. Likewise specimens with 10, 25 and 40% of temper of the same grading are very distinct in texture. These samples were prepared with red clay and sand temper, materials having poor contrast, and therefore demonstrate the possibility of recognizing differences of this magnitude in the majority of clay and temper combinations found in actual pastes. They seem to offer a feasible means of describing by reference to a standard, not absolute grain size or true volume of temper, but rather textural appearance, provided certain precautions are observed. The standards should be made of clay and temper having approximately the same color or degree of contrast as that of the paste being judged for it has been demonstrated experimentally that color contrast has an important effect upon both apparent size and abundance of inclusions. Grain size will often include several grades and only the range can be described. Actual volume of temper cannot be estimated because of the fine material which is invisible, and the terms sparse, moderate, heavy, when used by the field worker would have to be understood as describing the appearance as influenced by the proportion of medium to very coarse grains. A fractured surface gives the best standard for comparison, since relief, the pattern of light and shadow is usually observed in the paste and grinding the fracture to a plane diminishes the apparent difference in textures, reducing it to two dimensions instead of three. Photographic standards could not be used since the standard and unknown should be observed in the same light and with the same magnification. It would be possible to substitute for the prepared standards, sherds in which the grain size and volume of temper of megascopic proportions had been determined micrometrically. The experience of a number of workers should, of course, be compared before methods and standards are finally established. Present lack of standardization renders most textural description nearly meaningless. Some such method as that proposed would serve as a common denominator to bring the observations to comparable terms without unduly increasing the time required for description, especially as the standards would be prepared in a technological laboratory.

Properties of the clay, though not as important as grain size, grading, and amount of inclusions, also influence paste texture. The mechanical composition of a clay, together with its relative refractoriness determines whether the clay base will be compact and dense or loose and porous in texture. Visual impression of clay texture should be supplemented by observation of the way in which the paste breaks; if it

chips it may be described as dense or compact, if it crumbles it is friable. It is hardly practicable to distinguish between the factors of porosity and mechanical composition as affecting relative density. Although in extreme cases the rate of absorption of a drop of water will distinguish between a porous and a compact clay, in the middle range such a test is of little value and it is not a sufficiently direct or accurate measurement of porosity to justify timing the absorption of a drop.

The manner in which a paste breaks is affected by its texture and hardness. Coarse inclusions will tend to produce a ragged fracture, fine inclusions a smooth fracture. If the paste is hard and dense large grains may cause an irregular break, whereas the line of fracture in a soft friable paste is more easily controlled by direction of pressure. A fine, soft, friable paste has a square smooth break and a coarsely tempered dense paste, the most irregular and jagged one.

In judging the nature of fracture a uniform method of breaking the sherd should be followed. Direct pressure applied with the end of a triangular file will usually show whether the paste chips or crumbles but does not give a long enough break to show the character of the fracture. When pliers are used just sufficient pressure should be exerted to hold the sherd and the break made by leverage, the push always being made squarely and in the same direction. The fracture may vary in different directions of the vessel and it is therefore well to note the orientation of the sherd and habitually make either a horizontal or vertical break.

Mohs' scale of hardness (see p. 433) can be used by the field worker as well as by the technologist and if this property is defined it should be by reference to a standard. It may be found that the majority of types of a period or area do not differ appreciably in hardness but the exceptional ones are none the less significant for this reason, nor is there less necessity for an impersonal standard definition.

Surface Finish. Standards for the terms rough, smooth and polished as applied to surface texture have been proposed by March.[1] He calls attention to the factors of paste texture and workmanship, but emphasizes the uncertainty of speculation upon methods of workmanship. Mere theory of technique has, indeed, no place in description, which should admittedly be purely objective, but a study of finishing processes reveals characteristics, the recognition of which is no more subjective than is color reading. Observations of the methods of modern primitive potters and well planned experiments bring out the multiplicity of conditions influencing the appearance of the finished surface and prove the impossibility of giving accurate or satisfactory descriptions with a few simple textural terms.

The principal factors which affect surface appearance are color, hardness, and texture of the paste or slip clay, method of evening the vessel surface, and final finishing process. The texture of the paste, particularly the amount and grain size of the temper, will obviously affect the surface texture, but this effect may be largely offset by the method of evening the vessel. The importance of the finishing technique is most evident when a coarse-textured paste is used. There are three general methods of evening the vessel surface when it is in a plastic condition or immediately after moulding, namely: scraping with an edge held nearly normal to the surface,

[1] 1934, pp. 35-37.

rubbing with a smooth, hard tool generally having a convex face, and rubbing with a soft or yielding tool. If a coarse paste is scraped the particles of temper will be caught by the tool and dragged along leaving characteristic pits and striations. Rubbing with a resistant convex surface, on the other hand, tends to imbed the temper and if thoroughly done may leave the surface as smooth and even as that of a fine-textured paste. A water-worn pebble, a piece of gourd rind, or a smooth sherd may be used for the purpose with no marked difference in the effect. If the finger instead of a hard tool is used it will yield to protruding inclusions, only partially imbedding and leveling them and a characteristic roughness will result. A surface which has been smoothed with the fingers generally carries unmistakable markings, fine striations produced by the ridges of the skin and by fine inclusions which adhere to the fingers. These striations are distinguished from tool striations by shallowness, uniformity of depth and spacing.

A surface may be evened immediately after moulding, when it is leather hard, or after it is completely dried. The surface which was evened when dry can often be distinguished from that which was worked over with a tool immediately after moulding. If the moist clay surface is evened with a rubbing tool it is practically impossible to avoid slight depressions and undulations of surface, but if the vessel is scraped with a straight-edge when leather hard or if it is dried and subsequently rubbed with a piece of fine sandstone, or a similar abrading tool, a far truer plane is obtained. It may not always be possible to distinguish a carelessly sanded or scraped from a carefully rubbed surface, but an undulated surface is usually indicative of finishing in the plastic state. Evening when the clay is in either a leather hard or dry state is most practicable with a fine-textured paste since coarse inclusions are unavoidably caught and dragged from the paste, leaving a pitted surface.

Non-culinary vessels having a well smoothed surface may be either slipped or unslipped. In some cases it is difficult to tell whether a ware was slipped, particularly if the coat was very thin or if it was similar in color to the paste. But ordinarily the slip, if present, can be observed by examining with a hand lens a carefully fractured section through the vessel wall. The edges of that portion of a break which come under the pliers are likely to be crushed by pressure so that they do not give clear evidence of the surface finish. Peeling or abrasion may sometimes indicate the presence of a slip, but crazing, although often caused by unequal contraction of slip and paste, may occur on unslipped as well as slipped surfaces.

An exceptionally well smoothed but unslipped surface has sometimes been designated by the term "floated" on the assumption that this texture was produced after sundrying by working over the moistened surface in such a manner as to bring up or float the finer particles of the clay, thus covering the coarser material in much the same manner as is done in cement work. Either the finger, a cloth, a piece of fur, or even a polishing tool can be used in this process, but the surface must be quite wet and worked very lightly. Such a method obviously never results in either a very smooth or a highly lustrous surface, nor does it resemble the kind of finish usually designated by the term floated. This method may have been used to even the surface before applying a slip and is in fact so used by certain modern Pueblo potters. But experiment and careful observation prove that the very smooth, lus-

trous, unslipped surfaces do not differ in finishing technique from polished slipped surfaces. In other words the surface was compacted by rubbing with a smooth, hard tool; the process usually designated as polishing. The present usage of the term floated should, therefore, be discontinued and well smoothed, fine-textured, often lustrous unslipped surfaces should be designated by the term compacted, polished or simply well-smoothed, all of which are accurate and legitimate descriptions, whereas the term floated if taken literally gives an entirely false impression of both technique and appearance.

The principal characteristics of the slip which should be recorded are color, hardness, texture, and luster. The description of color and hardness have been discussed under paste and requires no further comment other than that the relation between hardness and wear should be noted. Textural differences are not as obvious as those of paste, since slip clays were very rarely tempered and fineness of grain was one consideration in their selection. Important differences do exist, however, the most marked of which is that between the clay with high and that with low colloidal content. The clay which is exceptionally fine and of nearly uniform grain size cannot be pebble-polished when damp, but is easily smoothed with a cloth or piece of buckskin, and when entirely dry it can be given some luster by polishing, whereas the more granular clay will take a high polish when damp but is marred by further polishing when dry. The explanation of these facts is simple; if the grains are graded in size they will pack or nest more closely than grains of uniform size and the closely packed surface reflects light more completely than the loose, open one. The Rio Grande Pueblo potters have recognized empirically the relation between texture and smoothing technique, for they seldom attempt to polish the highly colloidal Santo Domingo slip, but instead smooth it with a cloth. These facts are of interest to the archaeologist primarily because they suggest caution in estimating the amount of mechanical polish which a slip has received by its degree of luster alone.

The terms smoothed, lustrous, and polished should be clearly distinguished. Smooth is a textural term and is judged by feel more than by appearance. Luster refers to the degree to which the surface reflects light and should be judged by the degree of gloss or shininess observed when the specimen is held in such a position that its surface forms approximately the same angle with the source of light as with the line of vision. Polish and luster are often used synonymously, but polish suggests technique and luster more correctly describes a property which is affected by other factors in addition to workmanship, for a surface well worked with a polishing stone may actually be completely dull or matte in appearance, although it will always feel smooth unless subject to some defect such as abrasion or crazing. The effect of clay texture upon luster has been discussed. A high firing temperature may also modify polish. This fact is best understood from a consideration of the nature of a lustrous surface. Rays of light falling on a rough surface are reflected at all angles and this diffusion produces an appearance of dullness; whereas light rays falling on a perfect plane are reflected at the same angle, thus producing a brilliant gloss. The luster of a clay surface is proportional to its smoothness, evenness, and compactness. If, therefore, a well polished surface is heated sufficiently high to cause noticeable firing shrinkage the arrangement of clay particles will be disturbed and the surface,

though still even and smooth to the touch, will lose its high gloss. The primitive potter would naturally discover this fact by experience and probably wares which were fired sufficiently highly to cause shrinkage were not often given a high mechanical polish.

In describing a lustrous surface, the uniformity, as well as the degree of luster, should be noted. Dull streaks on a lustrous surface may be due either to indifferent polishing or to an ineffectual method of evening the surface before slipping, for if the surface is pitted or ridged it cannot be given a uniform luster no matter how faithfully the polishing stone is used.

Paint. Certain physical properties are characteristic of particular kinds of paint and thus aid in megascopic classification after the composition of the paint has been determined by test. The following characteristics should be recorded: color, luster, relief, hardness, evenness, spreading, and such defects as abrasion, crazing, and peeling. Mineral and vegetal pigments can, as a rule, be distinguished by the oxidation test (see p. 412) which being non-technical can be applied by the general archaeologist. Certain characteristics which usually distinguish the vegetal from the mineral pigment of Southwestern Black-on-white pottery may also be mentioned. The vegetal pigment lacks relief entirely and has approximately the same texture and luster as the clay surface upon which it is applied. This is because the pigment is in solution and penetrates the clay without noticeably disturbing the arrangement of surface particles. Any coating of organic matter which originally covered the surface is removed during firing by oxidation leaving the clay colored by that which has penetrated. The mineral pigments, on the other hand, are insoluble, being applied as suspensions. They form a coating upon the clay surface, consequently they often have distinct relief. Their texture is due to their physical condition, treatment (smoothing or polishing) which they may receive after application, and changes such as vitrification which take place in firing. Frequently the greatest contrast between an organic and a mineral paint is in luster, the latter being entirely matte or dull in contrast to the smooth glossy surface of the former when applied on a well polished slip, but mineral paints are sometimes polished after application and if vitrified they become lustrous, though in this case the surface is seldom smooth and there is distinct relief. Mineral pigments are often rough and granular in texture and they may be thick and caked in patches. The hardness of an organic pigment usually varies but slightly from that of the clay surface upon which it is applied, whereas the hardness of a mineral pigment bears no relation to that of the clay, if unsintered it may be noticeably softer, if vitrified it will probably be considerably harder. The mineral paints are also more often affected by wear than are the organic paints. The normal grays or black of organic and mineral pigments may be indistinguishable but when oxidized these paints exhibit distinct ranges which can best be studied from refired specimens.

This brief review of the megascopic observations to be made in the description of pottery suggests no new terms or striking innovations in method. From the standpoint of the technologist the essentials are accurate, systematic examination, reference to impersonal standards, and strict definition of terms. Some of the observations which have been suggested may seem unnecessarily detailed or even

trivial, but any of these characteristics may be distinctive of a type and so go to make up the archaeologist's impression of its appearance; while failure consciously to recognize and record just such minute details may in some measure explain the difficulty experienced in giving a description which will actually differentiate the type recognized.

For convenience and clarity the suggestions made are summarized in outline:

Paste

Color range, typical and exceptional colors, uniformity in color, and relative width of color zones described by reference to a standard color scale.

Inclusions—identified only when coarse and diagnostic features are unmistakable. Appearance described by color, luster, degree of transparency, and shape.

Texture—proportion and grading of visible grains estimated by reference to prepared standards made in accordance with the following definitions:

Sparsely-tempered—visible inclusions make up less than 15% of the volume of the paste.

Moderately-tempered—visible inclusions make up from 15 to 30% of the volume of the paste.

Heavily-tempered—visible inclusions make up over 30% of the volume of the paste.

Fine—inclusions under 0.25 mm. in diameter.

Medium—inclusions from 0.25 to 0.50 mm. in diameter.

Coarse—inclusions from 0.50 mm. to 1.0 mm. in diameter.

Very Coarse—inclusions over 1.0 mm. in diameter.

The texture as affected by the shape of inclusions described as *granular* or *laminated*.

The texture as affected by the character of the clay is described as:

Dense—fine, compact, chips rather than crumbles when broken, leaving a smooth fracture.

Friable—finely granular, crumbles when broken and the fractured surface is earthen.[1]

Fracture—the way in which the paste breaks is influenced by texture. It should be observed whether the direction of break is straight or irregular; whether it is at right angles or oblique to the vessel surface; and whether the fractured surface is smooth and fine, or rough and granular.

Hardness—is defined by reference to Mohs' scale.

Surface Features

Color—described by reference to a standard color scale.

Hardness—determined with minerals of Mohs' scale.

[1]This limits the term *friable* to instances in which the entire body of the paste has a weak bond and crumbles to a fine powder. Used in this sense the term is not applicable to those pastes which have a hard compact clay base even though they are weakened by coarse temper and so easily broken.

Evenness—surfaces may be designated as even or uneven according to the presence or absence of the irregular undulations which mark the imperfectly planed surface. If present record should also be made of: *a*—fine parallel ridges such as are produced by using the rubbing stone on the plastic clay: *b*—broad, shallow, depressions on the vessel's interior such as are indicative of the paddle and anvil technique.

Texture—the property resulting from texture of paste together with final finishing process may be described as:

Smooth—slick to the touch.

Rough—gritty to the touch.[1]

Granular—characterized by protruding inclusions. The term may be modified by the words medium, coarse, etc., depending upon the size of the inclusions. Such features as fine striations or pits should also be noted.

Luster—according to the amount of light which it reflects, a surface may be described as dull, lustrous, or highly lustrous. Uniformity of luster and presence or absence of marks of the polishing tool should be recorded.

Slip—recognized as a surface layer seen in fractured cross section through the vessel wall. *Thick* if visible to the unaided eye. *Thin* if seen only with a 10- or higher-power lens.

Defects may be significant marks of properties of the slip or paste and should be recorded.

Abrasion—rubbing away of a soft slip by wear.

Peeling—cracking and loosening of a slip which has a poor bond with the paste.

Crazing—the formation of a network of fine, irregular cracks by contraction.

Spalling—the deep flaking of the surface caused by the expansion during firing of accidental inclusions, or of steam.

Paint

Composition—organic distinguished from inorganic pigment by the oxidation test.

Properties to be recorded: color, luster, relief, hardness, evenness, and defects.

[1]The term rough is frequently used loosely to cover a variety of surface textures produced both by distinctive finishing processes and by paste texture. It is here proposed to limit the term to the textural characteristic of clay which has not been compacted in the finishing process and to define or describe specifically textural features resulting from inclusions in the paste and from particular finishing techniques.

MODERN PUEBLO POTTERY MAKING

A study of the methods of present-day primitive potters is of twofold value to the archaeologist, it aids him in visualizing the prehistoric potters' technique and problems and it answers specific questions directly in so far as conservatism has preserved ancient customs and practices. A study of pottery making calls attention to minute but important details and subtle marks of workmanship, which otherwise are all too easily overlooked. A good illustration of this fact is afforded by the paddle and anvil technique of the Hohokam. The smooth shallow depressions on the interior of vessels were recognized as marks of the anvil only after attention had been directed to the practice of this method of pottery making among modern tribes. Pottery in fact assumes a new importance and significance after we have watched every stage of its production. Sherds can then no longer be disassociated from the human beings who made them and merely classified and tagged by our impression of color and texture.

Although pottery making among the Pueblo Indians is fast becoming a curious mingling of ancient and modern technique, it is still a fruitful source of suggestion to the archaeologist who would understand the workmanship of the wares of the Southwest. It is of interest also to learn how the pastes, slips, and pigments of the ancient and modern potter compare. A study of firing is of particular value, since temperatures obtained in prehistoric times have been largely a matter of speculation. Of general interest to archaeologists also is the intelligence and care exercised in the selection of materials, the distance from a village of sources of clay, and the extent of trade in raw materials.

There are surprisingly few records of Pueblo pottery making, and with one or two exceptions they are vague and incomplete. The standard work, which treats workmanship with admirable accuracy and detail, deals with the group most influenced by modern tourist trade.[1] In view of this paucity of data and the usual generalized treatment, some of the observations which should be recorded by the student of pottery making are here outlined. Facts pertinent to archaeological problems are stressed and the subject is considered from the standpoint of the ceramist.

The Identification of Materials. The potter's materials must be identified and their properties tested in order to understand the relative skill and intelligence of the potter and to furnish a basis for the comparison of wares. The same methods of analysis which have been suggested for the study of archaeological material are equally applicable in ethnological investigations; temper is identified by the petrographic microscope, pigments by chemical analysis, while the character of the clay is revealed by its physical and optical properties and thermal behavior. The ethnologist has a great advantage over the archaeologist in that the raw materials are available for comparison with the finished product, and it is particularly important to collect large and representative samples. Whenever possible, the clay deposits should be visited and the formation and approximate amount of material which

[1]Guthe, 1925.

has been removed noted. The sources of pigments and temper should likewise be located and examined. It is interesting to learn how many distinct clays are used by the potters of one village, and how great the variations in their working and firing properties, as well as the frequency with which new materials are introduced. The distance of sources of supply from a village and the extent to which clays and pigments are traded are facts especially significant in relation to archaeological problems.

The Preparation of Materials. The potter's success is dependent in no small measure upon the way in which she prepares her clay. What method is used to reduce the clay and to eliminate foreign material? Is the clay ground, sifted, winnowed, floated, or soaked in water and the coarse particles picked out as the clay is kneaded? It has been found in commercial practice that the plasticity of clay is improved if it is aged or stored for some time in a damp condition. Did primitive potters discover this fact, or were they deterred by the difficulty of keeping the clay moist? What are the potter's ideas of the function of temper, and does she distinguish between clays of high and low plasticity and shrinkage, varying the amount of temper accordingly? What is her way of measuring the proportion of temper to be used, and is it mixed with the dry or wet clay? The actual grain-size of the temper can most easily be measured by sifting a sample through screens of standard mesh and weighing the amount retained on each screen. It may sometimes be possible to separate the temper from the paste by flotation, thus ascertaining the proportion of temper added to the clay. As there is little difference in specific gravity of clay and various tempering materials, the success of this method will depend upon the coarseness of temper. It is also important to test the plasticity, water of plasticity, and shrinkage of the paste. If a sample of the clay which is tempered, kneaded, and ready for moulding is collected and kept in a tightly sealed jar, these properties can be measured. Although there should be no appreciable loss from evaporation if containers are kept tightly closed, as a precaution tests should be made as soon after collection as possible.

Fine texture is particularly desirable in slip clays. The most effective method of refining clay is to stir it in water so that the coarse grains settle and the fine clay particles held in suspension can be poured off and then concentrated by settling or evaporation. It is uncertain from published records whether the modern Pueblos ever followed this practice. Stevenson, in describing Zuñi slip, says "... white clay is dissolved in water and then made into cones which are dried in the sun. When required for use these cones are rubbed to powder on a stone, again mixed with water, and applied in the liquid state to the object with a rabbit-skin mop."[1] This suggests flotation but the purpose and result of the so-called process of dissolving the clay in water is not stated. A Zia Indian in explaining the preparation of white slip told the writer that a substance, which proved to be marl, was stirred in water and the sand allowed to settle after which the liquid containing the finer material in suspension was poured off and mixed with whitish clay. Mixing different clays to alter color, and the addition of temper to counteract crazing, are points of interest. Guthe records

[1] 1904, p. 375.

the mixture of two clays and temper in the slip of San Ildefonso decorated redware.[1] The slip clay when mixed with water is usually described as having the consistency of cream or of water, but such statements are not sufficiently accurate for comparative purposes. The viscosity of the slip may vary within wide limits depending upon character of clay and the surface finish desired. If a sample of slip is obtained in a rubber-stoppered bottle, the amount of water used with a given weight of clay can be determined. The same should be done with paints. The fineness of mineral pigment and substances used as binders are also important facts to record.

Moulding and Shaping. Guthe's description of pottery making at San Ildefonso furnishes an excellent example of the observations which should be made in recording method of building coiled vessels. The size and manner of forming the base, the method of rolling the coils, and their diameter, the position of the hand in placing and welding coils, the amount of vertical overlap, manner of shaping, frequency of turning the support in the shaping process, and degree of finish given in the wet state are all significant factors.

Drying. Slow drying is necessary to avoid strain and weakness in a vessel. Does the Indian recognize this fact and take means of insuring slow, even drying by keeping vessels in the shade and away from the wind or under cover?

Finishing. Certain of the Pueblo Indians scrape the vessel when it is in a leather-hard condition to improve its symmetry, remove the marks of the support, and thin the walls. Guthe describes the process at San Ildefonso[2] where a case knife or the lid of a baking powder can is used; Mrs. Colton notes the use of a piece of sandstone by Hopi potters;[3] while the writer has observed the use of a piece of pumice by Cochiti and sandpaper by Santa Clara potters. Although scraping seems to be a well established custom, dependence upon carving for final shaping and thinning the walls seems to disregard the possibilities of plastic clay, and the surface characteristics of some prehistoric types show that it was not invariably done by ancient potters. Success in scraping a vessel when it is in the leather-hard condition depends to a certain extent upon the texture of the clay. If the paste contains coarse temper, scraping is difficult, and a rough pitted surface results. As far as the records show, potters who finish their vessels in this manner all use fine-textured pastes, and it is yet uncertain whether or not this is a universal practice among the Pueblos.

The slipping of a vessel involves some risk, for with excessive or uneven wetting there will be strain and resultant cracking. In modern commercial practice the slip is generally applied when the vessel is in the leather-hard condition which reduces the danger of cracking, but San Ildefonso potters do not slip until the vessel is completely dried,[4] and the same practice has been noted by the writer at Santa Clara and Cochiti. Preliminary treatment, such as moistening or smoothing the surface, the number of times the surface is gone over with each application, the number of coats and the time allowed for drying between applications, are all variable, but bear some relation to the kind of slip and the desired surface finish. A high degree of mechanical polish is characteristic of many of the modern wares. Experience shows that quality of clay and moisture both affect the result. If the

[1]1925, p. 24. [2]1925, pp. 54-56. [3]1931, p. 3. [4]Guthe, 1925, p. 56.

slip is too damp, especially if it has been applied on a dry surface, it will adhere to the polishing stone; if too dry, certain clays cannot be polished, and the difficulty is increased by excessively rapid drying when only a few coats are used on a dry body. Other types of clay cannot be pebble polished when wet but take a higher luster after drying; these are often effectively smoothed with a cloth or buckskin, or left unpolished. Different customs of finishing may, therefore, result from the quality of clay, and the relation of the two should be considered.

Painting. Method of laying out the design, order of painting motives, manner of holding the brush and the vessel, and the direction of strokes are all features worthy of record.

Firing is the final test of the potter's skill, yet results obtained with the crude and simple methods of some modern potters are amazing. The danger in firing lies largely in too rapid heating and cooling and in contact of fuel and pottery. Quick heating is almost unavoidable with direct firing, yet there is always danger that steam from hygroscopic water cannot escape as rapidly as it is formed and will burst the vessel walls. Air trapped between imperfectly welded coils will produce the same result. A dense carbonaceous clay will bloat upon rapid heating to the upper range of Pueblo temperatures unless the texture is very open. And if a vessel is well fired sudden chilling will cause it to spall and crack. An adequate record of firing should include, in addition to a description of arrangements for firing and kind and amount of fuel, a plot of temperatures and some estimate of the character of the firing atmosphere (see methods suggested on p. 419). A relation will sometimes be found between method of firing and the type of ware produced, as for example a short firing for wares decorated with organic pigments, and low temperature for wares having a high mechanical polish.

It is of interest to know upon what basis the Indian decides when the pottery has been sufficiently fired, whether she judges by the color of the hot vessel, times the firing, or simply lets a given amount of fuel burn out. Any precautions taken against too rapid initial heating, contact of fuel with pottery, and sudden chilling should also be noted.

The methods of the potters of a single village will differ, and a number should be observed to learn what are the established methods for the group, what parts of the technique are most subject to individual variation, and how much actual initiative and experimentation are shown. In so far as possible it is also of interest to ascertain the potter's reasons for her various procedures.

The study of Pueblo pottery making is obviously outside the scope of this report. It is the object of the present discussion only to review such data as are relevant to the investigation of prehistoric Rio Grande pottery and to present a record of firing temperatures, since this evidence has not hitherto been made available.

The Pueblo potters of today are using materials as diverse as are those found in the prehistoric wares of their respective localities. In many instances they are evidently following traditional custom in the selection of tempering material. The Tewa potters of San Ildefonso, Santa Clara, and San Juan all temper their clay with volcanic ash obtained from secondary deposits in the sediments of the Santa Fe

formation. The ash or tuff is light gray, exceedingly fine textured, and free from mineral inclusions. It has become compacted, but the lumps dug from the bed are easily crushed to a fine powder. It is therefore admirably adapted for use as temper, particularly as it makes a very fine-textured paste. Tuff temper has been continuously used in this area since Biscuit times and in some localities since Black-on-white times. Potters of two modern Keres pueblos, Santo Domingo and Cochiti, also use tuff temper, obtaining it from beds in the Tertiary sediments a few miles from their pueblos. As compared with the northern beds the material of these deposits is coarser, less consolidated, and contains more mineral inclusions.

Potters of the Keres pueblo of Zia grind for temper weathered basalt picked up among the cobbles about the village. Although the women complain of the hard labor of grinding the rock, there evidently has as yet been no effort to substitute sand or other unconsolidated material. As a matter of fact, trials have shown that this rock is easier to grind than potsherds of average hardness. This fact is perhaps explained by the alteration of the rock, decomposition having proceeded along the boundaries of minute crystals, which are therefore easily broken apart. The use of basalt temper by Zia potters is perhaps a direct survival from the custom of the late prehistoric potters who made Glaze ware.

The custom of the prehistoric Galisteo potters of Black-on-white times of using potsherd temper has not survived in the upper Rio Grande Valley but the potsherd tempered wares of the Western Keres pueblo of Acoma and of the pueblo of Zuñi are evidently a survival of the prehistoric technique in those localities. There is no known instance in which potters go beyond the limits of their own immediate territory for tempering material. In the beginning, the most suitable material offered by a locality may have been chosen through conscious forethought or experimentation, as in the case of tuff temper; but at the present time tradition seems to be the controlling factor and, in spite of many innovations in workmanship and finish, no variance from ancient practice in choice of temper has so far been recorded.

Body clays, like temper, are generally obtained from the immediate locality of the pueblo. The potters of San Ildefonso use red-burning, non-refractory, alluvial clay from two beds, one of which is one and a half miles north of the pueblo on the western side of the Black Mesa, the other in the Santa Fe formation one and a half miles south of the pueblo. Santa Clara potters use a similar clay obtained from beds at the foot of the mesa approximately two miles southwest of the pueblo and also from beds in the Santa Clara cañon.

Zia potters obtain a red-burning, non-refractory clay from deposits near the west bank of the Jemez river and just south of the Zia bridge. The location of the white-burning non-refractory clay of the Zuñi is described by Stevenson.[1]

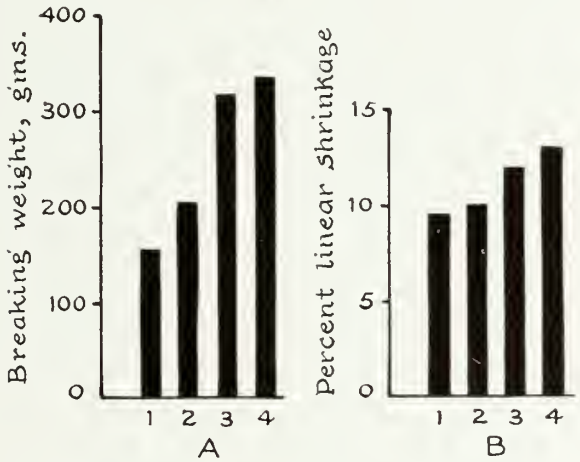
At the Tigua pueblo of Picuris a residual clay formed from the disintegration of gneiss is used for cooking pots. The clay beds have not been visited, but the characteristics of this clay and its method of preparation furnish an illustration of a type which has sometimes confused archaeologists. The fragments of unaltered rock which occur in the clay act as a natural temper and they are often so large and abun-

[1] 1904, p. 374.

dant that it is necessary for the potter to clean the clay and remove the coarser ones. Because of this fact more than one investigator has argued that clays were never tempered by the Indian, the mineral inclusions we find in them being of natural occurrence.

While few instances have been recorded of the use of body clays from distant sources or obtained in trade, such is not the case with slip clays. This fact is probably explained by the relative scarcity of fine-textured clays of pleasing color. San Ildefonso potters obtain red clay for blackware slip from beds in the Valle Grande of the Jemez range. Their descriptions of location are vague, but they say that a day is required to make the trip on horseback. The white slip of the Laguna Indians is obtained in trade by the Zuñi, while the San Ildefonso use the fine-textured cream-colored slip of Santo Domingo, traded from either Cochiti or Santo Domingo.

The quality of the clays used by the Pueblos at the present day varies within wide limits. It is worthwhile to compare them if only to show that poor pottery is not entirely due to faulty technique and low firing as we are often prone to believe. A comparison will also suggest how important quality of clay may have been in prehistoric times. A complete survey of ceramic materials of the Pueblos has not yet been made, and just sufficient data are here presented to give an idea of the range of differences.



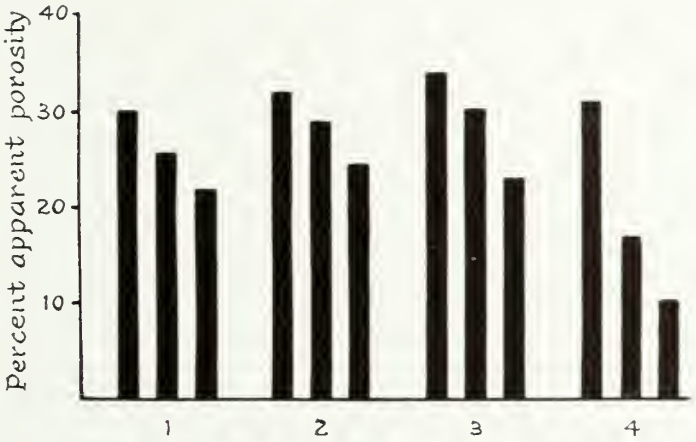
Graph I. Workability and shrinkage of Pueblo clays. A: Workability as measured by the weight required to break a rope of the plastic clay. B: Percent linear drying shrinkage. 1: San Ildefonso red-burning, non-refractory clay from deposit in Santa Fe formation, 1½ miles south of the pueblo. 2: Santa Clara red-burning, non-refractory clay from Santa Clara Canon. 3: Zuñi buff-burning clay from Corn Mountain. 4: Zia red-burning, non-refractory alluvial clay from bank of Jemez River.

The plasticity and shrinkage of the raw clay and its strength and porosity when fired to given temperatures, have been measured.[1] These are the properties which

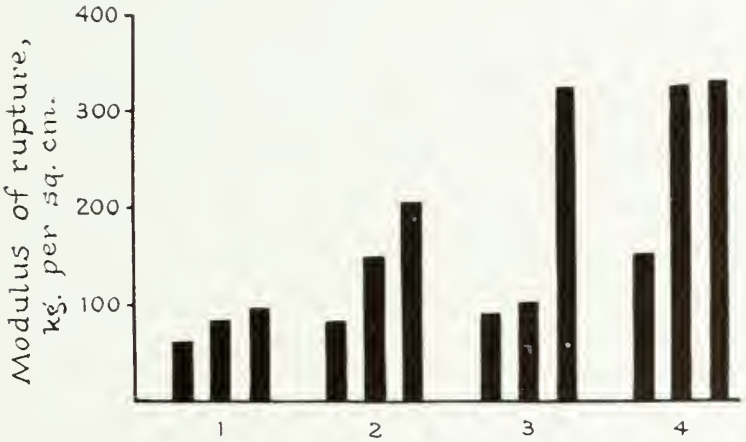
[1]For description of test methods see pp. 404-405, 434-437.

most directly concern the potter and results of the tests are best shown graphically. It will be observed (see Graph I) that the clay with the highest plasticity, Zia, has more than twice the value of the lowest, San Ildefonso; Santa Clara is similar to San Ildefonso and Zuñi is similar to Zia. The same order is shown in shrinkage, therefore while Zia clay is the easiest to work it is also the most liable to cracking upon drying and requires the largest percentage of temper. The firing shrinkage is small compared to the drying shrinkage; when fired to 1050° C. the shrinkage of the San Ildefonso and Santa Clara clays is 1.1% and of Zuñi 3.4%. The Zia clay bloats at this temperature and therefore measurements could not be made. The porosity and strength of these clays, untempered and when fired to 650°, 850° and 1050° C. are shown in Graphs II and III. The porosity of the San Ildefonso, Santa Clara, and Zuñi clays decreases very gradually and uniformly within this temperature range. The Zia clay shows a much greater decrease at the intermediate temperature and at the high temperature has less than half the porosity of the other three clays. A comparison of the curves for porosity and strength shows the relationship of these two properties, but differences in the latter are more marked than in the former. The San Ildefonso is a decidedly weak clay and has a comparatively slight increase in strength at the high temperatures; the Santa Clara is somewhat stronger and shows a greater rate of increase; the Zuñi is weak at the lower temperatures with a very marked increase of strength at the higher. The Zia is decidedly stronger at the lower temperature than the others. It is somewhat erratic at the higher temperatures because of the development of gas blebs. The curve plotted represents the average. If the clay had been tempered it would have been sufficiently open in texture to permit the escape of the gas which causes bloating. The marked differences in strength of these four clays when fired to the same temperatures and under the same conditions brings out the importance of thermal behavior of a clay in its effect on the hardness and strength of a vessel.

There has been much speculation regarding Pueblo firing, temperature range, difference in temperatures used for the various wares, and the maximum temperature that can be obtained with the present method of firing. The first attempt to measure heat treatment in Pueblo firing was made by the late Wesley Bradfield in 1929. Pyrometric cones were used at San Ildefonso in the firing of Polished Black and Polychrome ware by Maria Martinez. Interesting indications were obtained from these tests, but cones do not measure temperature but rather show the effect of time and temperature (see p. 422). They are also affected by reducing gases and consequently are of little value in studying the firing of black ware. The first measurement of temperature was obtained by the Laboratory of Anthropology in the fall of 1932 by the use of a thermoelectric pyrometer and chromel-alumel thermocouple. When measurements were made, the two-foot thermocouple was set with its tip as near the center of the heap of pottery as possible when the vessels were being placed on the grate. Readings were made at five minute intervals and more often when the temperature was approaching maximum, or when fuel was added. Records have now been made at San Ildefonso, Santa Clara, Cochiti, and Zia. Temperature curves for the firing of Polished Black ware are given in Graph IV. A great difference will be observed in the length of firing but temperatures are in all cases low and the



Graph II. Percent apparent porosity of Pueblo clays. Numbers the same as in Graph I. The three lines in each group represent, from left to right, the apparent porosity of test pieces fired to temperatures of 650°, 850°, and 1050° C.

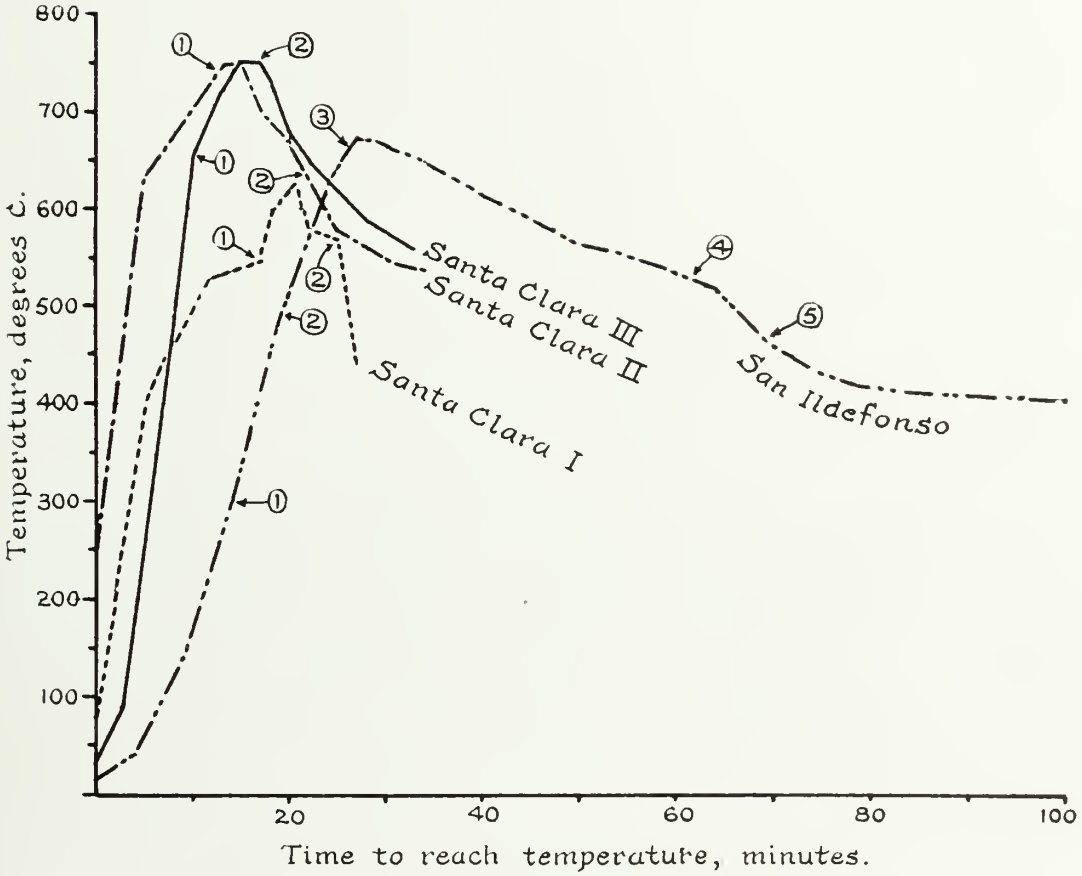


Graph III. Modulus of rupture of Pueblo clays. Numbers the same as in Graph I. The three elevations represent, from left to right, the breaking weight in kilograms per square centimeter of test pieces fired to temperatures of 650°, 850°, and 1050° C.

initial rate of heat increase very rapid. There is a striking contrast in the skill and care of different potters. The firing of Polished Black ware at San Ildefonso by Maria and Julian Martinez was marked by methodical preparation and by the systematic, orderly, and confident manner in which every part of the firing was conducted.[1] The vessels were inverted on a specially constructed grate supported on tin cans kept for that purpose. The thirty-seven pieces averaging five to eight inches in diameter, were completely protected from direct contact with the dung by pieces of sheet-iron, and the pile was covered with dung chips before the juniper kindling was ignited. Thirteen minutes later, fine juniper chips were thrown over the heap. This caused the flame to blaze up nearly seven feet, but produced no noticeable difference in the heat curve. The fire was smothered after it had burned twenty minutes, and the temperature began to drop three minutes afterward from the maximum of 670° C. The decrease in temperature was accentuated after forty minutes when the removal of the sheet-iron allowed the escape of heat, but the curve flattened out six minutes later when the heap was covered with ashes, which served as an insulator. The time allowed for the smudging was four times the length of the firing. Maria timed her firing and particularly the smudging of her ware.

Records were made of firings by two Santa Clara potters. Although they are experienced women whose work is classed with the best produced at the pueblo, their methods are marked by carelessness and lack of preparation. Old Ford springs supported on tin cans formed the unsteady rest for pots which were placed while the preliminary fire, kindled to warm the pots and dry out the ground, still smouldered. Chips of the cow dung fuel were set on edge completely surrounding and covering the pottery, though spaces between chips allowed ample draft. Chips frequently slipped from place in spite of the fact that pieces of old iron were rested against them at critical points. As soon as the dung was ignited the temperature increased very rapidly, as shown in the three temperature curves (Graph IV). The initial temperatures recorded differ because the preliminary fire had burned out more completely in one case than in the others. Before the combustible material entirely burned out, the fire was smothered with fine manure dust to blacken the pots. A few minutes after the smothering, which completely shut off the draft, the temperature began to drop rapidly. Two curves (Santa Clara II, III, Graph IV) represent firings made six months apart by the same woman. She did not know until afterward that her second firing exactly duplicated the maximum temperature of the first, 750° C. Approximately the same bulk of pottery, three jars averaging ten inches in height, was fired each time. The potter watched the vessels through chinks between the fuel and considered that they were properly fired as soon as they became a bright clear red. The second Santa Clara potter observed fired a *tinajon* eighteen inches in height. Although potters had several times volunteered the statement that large jars are fired hotter than small ones the maximum temperature in this firing was only 625° C. and the uneven firing curve (Santa Clara I, Graph IV) indicates the poor control of the fire. The time allowed for smudging was surprisingly short, only six minutes, but the tinajon was perfectly blackened and gave no hint in its appearance of the amazingly careless firing treatment it had received.

[1]For a detailed description of the procedure see Guthe, 1925, pp. 70-88.

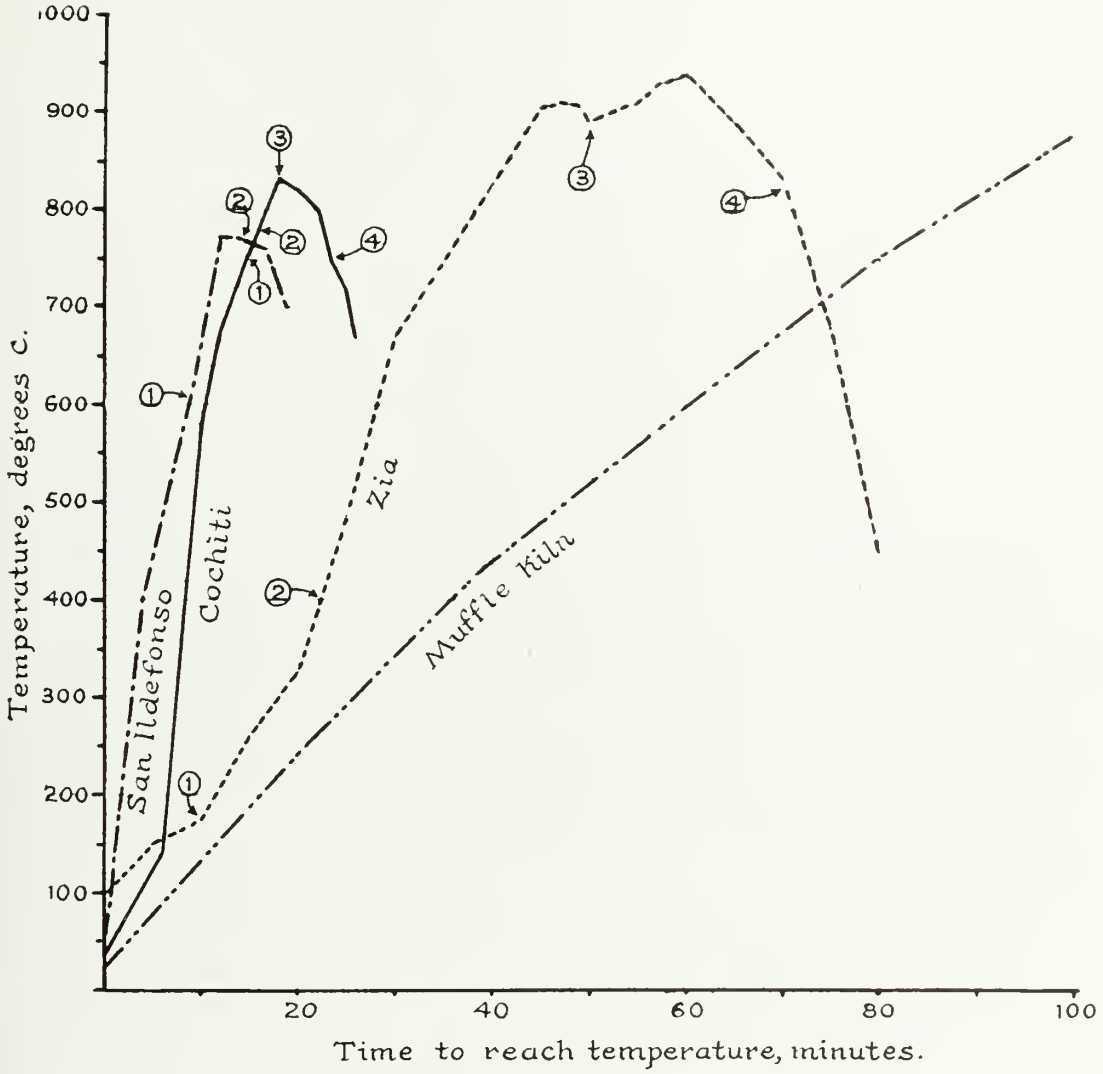


Graph IV. Temperature curves, firing of Pueblo Polished Black ware. For meaning of ringed numbers, see below. *San Ildefonso*, Maria and Julian Martinez, April 7, 1933. Thirty-seven pieces of pottery fired. 1: A few pieces of dung and juniper kindling added to fire. 2: Juniper chips and bark thrown over outside of heap. 3: Heap covered with two wash-tubs full of fine manure. 4: Pieces of sheet-iron removed. 5: Heap covered with ashes. *Santa Clara I*, Lufina Baca, April 11, 1933. A *tinajon* 18 inches in height fired. 1: Some fine manure thrown on which accelerated the fire at first, continued to throw on fine manure in small baskets-full and fire was completely smothered just before maximum temperature was reached. 2: Sheet-iron drawn out and manure raked closely over the jar. *Santa Clara II*, Eulogia Padilla, October 15, 1932. Three jars, 1 bowl, 4 ash trays fired. 1: Fire smothered with fine manure. 2: Manure pushed into close contact with pottery. *Santa Clara III*, Eulogia Padilla, April 11, 1933. Three jars, two candlesticks fired. 1: Started to throw on fine manure. 2: Heap completely covered with manure.

The highest temperatures so far recorded among the pueblos was that attained in the firing of Zia Polychrome pottery, a ware decorated with a mineral pigment. The potter whose method was observed took pride in the fact that she fired well, but the day was windy and she was not satisfied with her fuel, part of which was not perfectly dry. She used principally slabs of sheep and cow dung from the corral, but also some cow chips from the pasture. Forty small bowls, averaging five inches in diameter, were placed on the grate, which was made from an old tire rim. The dung was placed on edge, the first tier resting on stones at the base and separated from the pottery at the top by flattened tin cans. Fuel was occasionally added after the heap was ignited, dung at first and later dry corn cobs. After the bulk of combustible material had burned out from the dung, which was graying with ash, and the temperature had started to drop, corn cobs were poked in the openings around the sides and top of the pile. The temperature was spurted up ten degrees to a maximum of 940° C. by this fresh fuel (Graph V). As soon as the fuel was burned out, though the temperature registered 800° C., the remaining chips, now largely ash, were raked off and the pots exposed to the cold breeze.

The temperature curve for the firing of Cochiti decorated ware, when compared with that for Zia Polychrome, suggests the limits placed upon time and temperature by the use of an organic pigment (Graph V). The Cochiti curve, however, is very similar to that of the Tewa firing in oxidizing atmosphere, as shown in either the firing of red ware or in the first stage in the firing of black ware. Rapid increase in temperature is the result of direct heating, and short firing may be a condition imposed by the character of the ware, or may simply reflect the indifference of the potter to the quality of her ware.

The firing data illustrate the degree of individual variation as contrasted with the difference between wares. At Santa Clara the maximum firing temperature of two potters was 625° and 750° C., a difference of 125°. The time required to reach maximum temperature in these two firings differed by only half a minute but in two firings to the higher temperature by the same potter, there was a time variation of five minutes. The time required for smudging varied from 10 to 19 minutes. In the firing of black ware at San Ildefonso more time was required to reach maximum, twenty-seven minutes, although the temperature was low, 670° C., and the smudging time was over five times as long as the maximum observed at Santa Clara. The San Ildefonso firing is perhaps exceptional because Maria and Julian are very particular in their methods. In the firing of San Ildefonso red ware the maximum temperature obtained, 770° C., is near the higher temperature of Santa Clara firing; in both instances the potter decided when the vessels were properly fired by observing their color. Three Cochiti firings were observed, only one of which is shown in the graphs. Two of these were by the same woman and maximum temperatures were 825° and 890° C., a difference due evidently to weather conditions rather than to the intent of the potter, as there was a strong wind and good draft the day of the higher firing. The second potter obtained a maximum of 830° C., and the time required to reach maximum in the three firings differed by only three minutes, from fifteen to eighteen, and total firing time by nine minutes, from seventeen to twenty-six. The Zia firing may not be representative. The longer time required to reach maximum may have



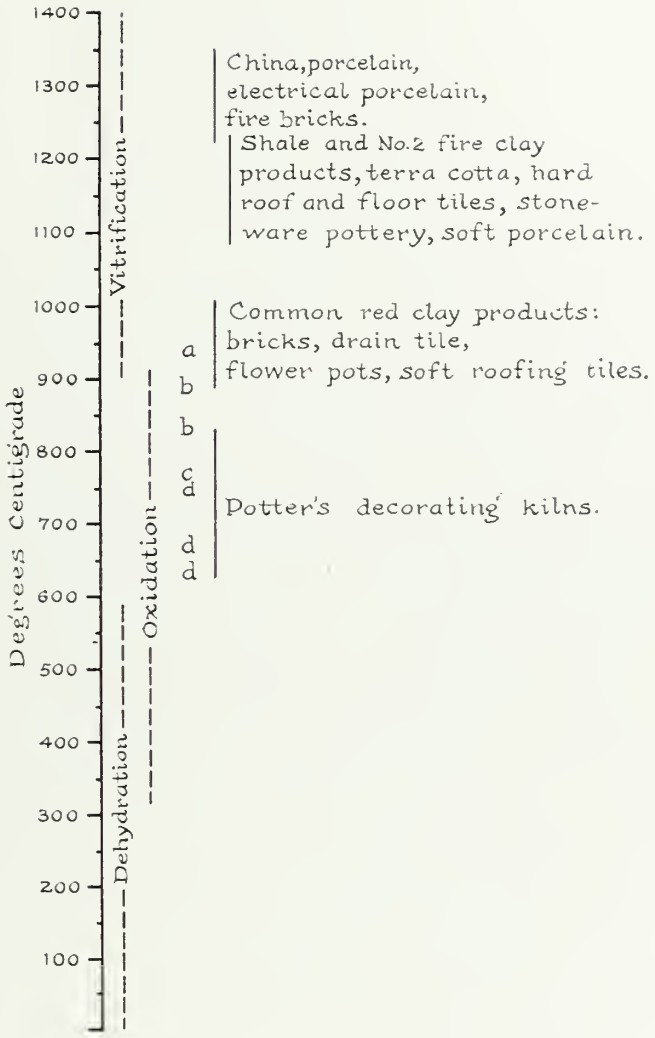
Graph V. Temperature curves, firing of Pueblo pottery compared with maximum rate of heat increase obtained in gas-fired muffle kiln. For meaning of ringed numbers, see below. *Zia*, Polychrome ware, Virginia Sala, April 1, 1933. Forty bowls averaging 5½ inches in diameter fired. 1: Pottery in place, started to set dung around sides of heap. 2: Finished covering heap with dung. 3: Corn cobs added in openings over heap. 4: Started to remove pottery. *San Ildefonso*, Polished Red ware. Rose Gonzales, July 7, 1933. Eight pieces of pottery fired. 1: Juniper kindling added under grate. 2: Started to remove covering of dung. *Cochiti*, ware decorated with vegetal pigment, Ascension Benado, October, 1933. Two bowls and one jar fired. 1: Sticks of cottonwood added under the grate. 2: Sheet-iron on windward side removed. 3: Cottonwood added. 4: Sheet-iron removed.

been due in part to damp fuel and the nervousness and embarrassment of the potter, which was not evident in the other women observed. It is possible also that the high temperature may not be characteristic of Zia, since this woman prided herself on her high firing and may even have been trying to create a good impression. It is probable, however, that higher temperatures are used at Zia, Acoma, and Zuñi than at the Tewa pueblos and a thorough study of the firing methods of the former group will be of especial interest.

The relation of these temperatures to the principal periods of firing recognized in modern ceramic practice and also to the temperatures used for modern wares is illustrated in Graph VI. It will be observed that the Zia ware comes within the range of temperature employed for red clay products such as common bricks and flower pots, and within the lower range of the vitrification period, while the black wares are fired at temperatures below the recognized limits of the vitrification period, and also considerably below those used for any modern ware, actually at the lower limit used in potter's decorating kilns.

The extremely rapid rise in temperature resulting from primitive direct firing can best be appreciated by comparing the curves plotted for the Pueblo firings with one representing the maximum rate of heat increase obtained in a gas fired experimental muffle kiln (Graph V). The great difference is explained largely by the time required to heat the muffle of the kiln, but even the kind of fuel used by the Pueblo is of such a nature as to produce rapid combustion. The organic matter in dung is in a fine state of division and readily accessible to oxygen, since the texture is loose and open. Dung, particularly that from the pasture which has been exposed to dust, has a high percentage of ash. When the bulk of the combustible material is consumed enough ash remains to retain the shape of the chips. The ash acts as a very effective insulator, it keeps heat in the improvised kiln, but it also reduces the heat that is radiated inward from fresh fuel thrown on the heap.

When the very rapid heating and quick cooling of these firings is compared with the firing schedule of the modern ceramist, in which the most efficient temperature for dehydration and for oxidation is maintained until these processes are carried to completion, it is no small cause for wonder that the Indian has so few accidents in firing. The fact that the pastes are porous and open textured with slight, if any, vitrification, accounts to a large extent for the fact that there is not a greater loss from sudden chilling.



Graph VI. Firing temperatures of Pueblo pottery compared with the temperature range of the principal changes which take place when clay is fired and with the temperature range employed for commercial clay products. *a:* Ware decorated with mineral pigment, Zia. *b:* Ware decorated with vegetal pigment, Cochiti. *c:* Polished Red ware, San Ildefonso. *d:* Polished Black ware, San Ildefonso and Santa Clara.

TECHNOLOGY OF THE PECOS WARES

The technological study of Pecos pottery was undertaken with the idea of testing the value and significance of technological data. Pecos material has several distinct advantages for this purpose. The site was continuously occupied for a long period of time, and the stratigraphic position and relation of types have been fully established. These conditions are essential to the historical study of the potter's craft. The investigation of trade relations has been greatly facilitated by the location of the site within an area of diverse geologic formations.

With few exceptions, changes in classification of wares and types have not been suggested as a result of the technological analysis, because it is believed that these two categories should be defined primarily by stylistic features. The terms *ware* and *type* are here used in the same sense in which they have most frequently been employed in archaeological literature, but as this does not agree with certain specific definitions, the usage may briefly be explained. *Ware* designates a ceramic group in which surface finish and manner of decoration remain constant, as, for example, Black-on-white, Red, Incised, and Corrugated wares. This is a broad term and has no specific cultural or chronological implications. The word *type* designates the division of a ware in which the styles of decoration and form are constant. A group in which material and technique, as well as style, are identical is referred to as a *subtype*.

Particular care has been exercised to select representative sherds for analysis, and, whenever available, material from stratigraphic tests has been studied. Fifteen to twenty-five specimens of each type, depending upon its variability, have been analyzed petrographically, a total of 572 thin sections of Pecos pottery having been thus examined in the course of the investigation. Although a general comparative study of Pecos pottery and that of the Upper Rio Grande region was not attempted, 385 sections of sherds from other sites in that area were made for the solution of specific problems. In addition to the thin sections analyzed, powder from five hundred sherds was examined in refractive liquids. Finally, in tracing the stratigraphic occurrence of types and subtypes, the paste composition of which had been determined petrographically, 4,300 sherds were classified with the binocular microscope. Grain size and volume of temper were measured in five sections of each type, three of which were from average or typical specimens and the other two from the extremes. Sections were selected for quantitative analysis only after texture had been carefully studied in all thin sections of the type. In defining physical properties, a minimum of ten sherds was tested. All thin sections, control sherds, and test specimens from synthetic experiments are on file at the Laboratory of Anthropology in Santa Fe and available for reference.

Data and interpretations are presented separately in order to draw a sharp line between fact and theory. Part of the data presented in the descriptions will, however, be of little practical value to the archaeologist, since some of the properties tabulated are unfamiliar to him and the standards used for the description of others are not in general use; certain properties, moreover, though variable, do not differ

greatly from one type to another. It was necessary at the start to consider the applicability and value of many tests and procedures and results have been given in full only after serious debate, principally because they furnish a demonstration of the relative significance of the different methods of analysis which have been used and because they enable the reader to draw independent conclusions.

BLACK-ON-WHITE WARE

BLUE-GRAY TYPE

Megascopic observations. The paste of the Blue-gray type is exceptionally uniform in color and texture. Inclusions are sparse, mainly submegascopic. Occasional medium or coarse sand grains and clay lumps seem to be accidental. Microscopic examination shows three distinct kinds of inclusions—fine sand or silt, tuff, and potsherd. Sherds belonging to these three groups cannot be distinguished by surface finish or form, and the inclusions can seldom be recognized.[1] Particles of tuff large enough for megascopic identification are present in only 2 or 3% of the total Blue-gray sherds, i.e., from 10 to 15% of the tuff-tempered specimens. The flakes of tuff are irregular and whitish. In direct sunlight their glassy appearance and vesicular texture can sometimes be made out with the aid of a 10-power hand lens and they are easily crushed with a needle point. Large particles of tuff might occasionally be confused with lumps of whitish limestone, but the two can be distinguished by the hydrochloric acid test.

The subtype with sherd temper is of rare occurrence and present only in the early levels of Forked Lightning refuse; material for complete analysis was, therefore, not available. The other two subtypes (one with silt inclusions and one with tuff temper) of Blue-gray type of Black-on-white ware require separate description.

BLUE-GRAY WITH SILT INCLUSIONS

Inclusions. The majority of Blue-gray sherds contain silt or very fine sand composed principally of subangular grains of quartz and feldspar (fig. 305, *a*).[2] Quartz frequently contains streamers of minute black inclusions. Feldspars are relatively clear but are sometimes grayed by decomposition or partially altered to sericite. Small flakes of pale green mica are characteristic, and biotite in larger flakes

[1] The fact that a reference to tuff in this and another type has appeared (Mera, 1935, pp. 14, 16.) gives an erroneous idea of the possibilities of megascopic identification. Tuff-temper was not recognized and its presence in the Black-on-white types of this area was not even suspected before the petrographic examination was made. Since the publication of Mera's paper the inclusions in Jemez Black-on-white, which he describes as "fairly large, rounded, translucent particles" (p. 23), have been examined petrographically and found to be coarse, pumiceous tuff and phenocrysts similar in texture to those characterizing a late variant of Blue-gray (see p. 463). The tuff of Jemez Black-on-white is many times coarser than any found in typical Santa Fe and is the one kind which the writer thought could be recognized megascopically. The fact that it was not so identified by Mera suggests that comments made in the present paper regarding the possibilities of megascopic identification may be too optimistic.

[2] Figs. 305-309 will be found on pp. 567-575.

occasionally occurs. Of the other minerals found in this particular subtype, common hornblende, blue-green tourmaline, zircon and magnetite are most constant in occurrence, while grains of titanite, apatite, augite, basaltic hornblende, and garnet are less frequently found. Sherds differ noticeably in the number and variety of accessory minerals, but clear evidence of distinct sources was not found. Accidental inclusions—lumps of marl or impure limestone—are present in all sherds examined. Rounded lumps of clay (0.1 to 1.2 mm. in diameter), similar to the body clay but darker and more dense, occur in all sherds and are numerous in some. Occasional reddish-brown clay lumps or gray lumps streaked with red were also noted. Large fractures of siltstone—composed of grains of quartz and feldspar (0.04 to 0.08 mm. in diameter) and a few flakes of pale green mica, cemented by marl—are sometimes present; fractures of granite and small fragments of microfelsite are rare.

Texture. Average grain size of inclusions—0.06 mm. in diameter; range in average—0.05 to 0.08 mm.; maximum grain size of fine-textured sherds—0.16 mm.; of coarse-textured sherds—0.64 mm. There is no apparent relation between maximum grain size and amount of silt, for coarse fragments are found in sherds having few inclusions, and a preponderance of small particles was found in many sherds which approached the maximum in volume of non-plastic material. Average grading: very fine—92.8%; fine—5.8%; medium—1.4%. *Volume of inclusions:* Average—14.4%; range—10.7 to 18.8%. Clay lumps negligible to 19.8% of paste volume. Silt is generally well assorted with relatively little difference in grain size, giving the majority of sherds an even, uniform texture. Exceptional sherds are found in which numerous clay lumps and scattered grains of sand tend to give the paste a non-homogeneous appearance. There is no noticeable orientation of inclusions or clay particles.

Clay is dark olive or grayish olive in transmitted light, isotropic or weakly birefringent. Refractive index—1.560.

Physical properties. *Color* range is limited and core-margin variations are rare. The majority of sherds are 15″″″ to 15″″″f (Mouse Gray to Pallid Mouse Gray) and hues between these and Neutral Gray. The *b* to *d* tints predominate. Tints paler than *f* are rare. Occasional pastes show tints of 17″″ and 21″″ (Drab and Grayish Olive). Oxidized by refiring at 850° C. for 30 minutes—15″ (Cinnamon). Refired to 1200° C.—9″k (Walnut Brown) to 9″l. *Hardness.* 3 to 3.5, rarely 4, very rarely 5. Unslipped and carelessly smoothed exterior surfaces are usually of the same hardness as the paste. Refired to 1200° C.—7. *Modulus of Rupture.* Average—122 kg. per sq. cm.; range—99 to 167. *Strength of Vessel Walls.* Average—30 kg. per 2.5 cm.; range—20 to 52. *Apparent Porosity.* Average—27.5%; range—25 to 30%. Refired to 1200° C.: Average—4.75%; decrease—80.2%.

Slip. *Color* range includes tints of 15″″″ to Neutral Gray occasionally whiter than *f*. Surface and paste colors are sometimes identical. Oxidized at 850° C. for 30 minutes—15″f or 15″d (Pale Pinkish Cinnamon or Light Pinkish Cinnamon). Refired to 1200° C.—9″ (Testaceous) to 9″l and may show bronze iridescence. *Hardness.* 4 to 4.5. Refired to 1200° C.—7. *Thickness.* 0.02 to 0.03 mm. *Finish and Wear.* Slips are smooth but not highly lustrous. They rarely craze, but the softer slips show wear. *Optical Properties.* The color is olive in transmitted light,

whitish in incident light. The clay is isotropic and not unlike that of the paste except for fineness of texture and absence of mineral inclusions. Refractive index—between 1.546 and 1.553. The slip is well amalgamated with the body and the contact zone is often darker than either paste or slip.

PAINT is organic. *Color* varies from Carbon Gray 6 (Dark Gull Gray) through Neutral Gray to 15″″i (Deep Mouse Gray) and 15″″m (Blackish Mouse Gray). Black is rare. The paint is smooth and without relief. It usually penetrates the slip completely and has the same luster.

FIRING. Paste color indicates imperfect oxidation. Calcite was not found but fragments of marl are common. Although these may possibly have been recarbonated after calcination, no example of spalling caused by hydration of lime was noted.

TUFF-TEMPERED BLUE-GRAY

TEMPER. The tuff or volcanic glass which distinguishes this variety of Blue-gray is variable in texture. Flakes streaked by flowage lines or drawn-out vesicles, and lunar, forked and irregular forms from bubble rims are typical. Coarse-textured sherds often contain highly vesicular pumiceous particles, while in the finest-textured paste only small angular fragments of clear glass are seen. Mineral inclusions, principally angular to subangular grains of quartz and feldspar, are sparse, forming a small percentage of the total tempering material. The feldspars are unaltered and include microcline, sanadine and oligoclase. Accessories are rare, biotite and brown hornblende being the most constant; pale green augite and zircon are uncommon. Lumps of clay similar in optical properties to the clay of the paste are present in some sherds. Limestone or marl is rarely noted.

Some specimens of a coarse-textured variety of Blue-gray, which is limited in occurrence to the latter part of the Black-on-white period, contain a distinct kind of tuff, figure 306, *e*. Associated with particles of pumice are clear crystals of oligoclase containing numerous inclusions of glass. Occasional fragments of microcline are free from glass. Slender prisms of hornblende occur in the tuff and fragments of augite are not uncommon. There are also a few fractures of cryptocrystalline rock having marked spherulitic structure.

TEXTURE. The majority of flakes vary from 0.05 to 0.10 mm. in diameter in typical specimens, are under 0.08 mm. in fine-textured pastes, and range between 0.16 and 0.32 mm. in pastes tempered with pumiceous particles. The maximum grain size is between 0.24 and 0.64 mm. in typical specimens, 0.16 in fine-textured specimens and 1.0 mm. for pumiceous temper. Grading of temper cannot be accurately determined in this type because the outlines of thin flakes of glass are often indistinct. *Volume of temper* cannot be determined by the Rosiwal method, and clay cannot be separated from the temper by rational analysis.

CLAY appears yellowish olive in transmitted light. It is weakly birefringent and sometimes has a stranded appearance under crossed nicols, a fact which suggests that the particles of clay are uniformly oriented. Refractive index—1.546 or 1.541.

PHYSICAL PROPERTIES. *Color* is usually 15″″ to 15″″d (Mouse Gray to Pale Mouse Gray), but tints of 17″″ and 21″″ (Drab and Grayish Olive) also occur.

Oxidized at 850° C. for 30 minutes—15″ or 15″d (Cinnamon or Light Pinkish Cinnamon), occasionally 13″ (Orange-Cinnamon). Refired to 1200° C.—9′l. *Hardness.* 3 to 3.5, rarely 4. Refired to 1200° C.—7+. *Modulus of Rupture.* Average—123 kg. per sq. cm.; range—102 to 160. *Strength of Vessel Walls.* Average—25 kg. per 2.5 cm.; range—14 to 33. *Apparent Porosity.* Average—31.2%, range—27.2 to 34.6%. Refired to 1200° C. Average—2.25%; decrease 92.8%.

Slip. The majority of sherds are slipped on the interior only; a few are unslipped, and rarely a specimen is slipped on both interior and exterior. *Color.* 17″″f (Pale Drab-Gray) or slightly paler. Oxidized at 850° C. for 30 minutes—15″b to f (Pinkish to Pale Pinkish Cinnamon), 13″b (Vinaceous-Cinnamon). Refired to 1200° C. the color of thinner slips is masked by fusion with the paste; thicker slips are 21‴ (Dark Olive-Buff). *Hardness.* 2.5 to 3.5, rarely 4. Refired to 1200° C.—7+. *Thickness.* 0.01 to 0.03 mm., rarely 0.06 mm. *Finish and Wear.* Surfaces are smooth but rarely uniformly or highly lustrous. Most specimens show nearly horizontal strokes of a smoothing tool. Thin slips are often uneven and streaked. Abrasion is common but no example of crazing was found. *Optical Properties.* The clay is light brown in transmitted light, whitish in incident light, weakly birefringent. Refractive index—1.549. Very fine-textured and mineral inclusions are rare. Scattered grains of quartz, 0.01 to 0.05 mm. in diameter, occur in some slips and small flakes of tuff were found in one specimen.

Paint is organic. *Color* usually 15⁗k to i (Dark to Deep Mouse Gray) often streaked with 15⁗b or d (Light or Pale Mouse Gray), rarely 15⁗m (Blackish Mouse Gray) or darker. Oxidized at 850° C. for 30 minutes—15⁗, 15⁗a, or 15⁗f. Luster is dependent upon polish of slip, usually matte or shiny only in streaks; a few specimens are highly lustrous. The paint penetrates the full depth of the slip.

Firing. Mineral inclusions of this subtype do not indicate firing temperature. Color comparison of refired with original paste shows that it was not oxidized.

CRACKLE TYPE

Megascopic observations. Typical Crackle Black-on-white is readily distinguished from the Blue-gray type. The paste of the former is frequently whitish and darker cores are often observed in cross-section. The clay appears dense and compact, and when a sherd is broken it chips rather than crumbles. The fracture is generally uneven and ragged. The amount and grain size of temper are variable, but its characteristics can be made out with the aid of a 10-power hand lens in approximately half of the sherds. Angular, dull, opaque gray fragments (potsherd) are seen, while translucent or transparent grains are rare. Although potsherd temper appears very different from sand, it may be confused with certain types of rock, and megascopic identification of even the more coarsely-tempered specimens is not infallible. One variety of Crackle contains particles of magnetite which superficially resemble fragments of black sherd, and if identification is uncertain particles should be picked out and tested with a magnet. The characteristic from which the type received its name, i.e., the crazing of the slip, does not occur on all specimens, but slip on the majority of specimens is distinctly harder than those of Blue-gray type.

Temper is, with few exceptions, ground potsherd. Particles of sherd temper differ in color, texture and temper, since sherds from different wares were used even in the same vessel (fig. 305, *b*). The characteristics of some are significant. No fragment from a vessel which itself had originally been sherd tempered was found. Cooking-pot fractures distinguished by sooty black color and coarse temper are present in approximately one-quarter of the sherds. Carbon from these fragments not infrequently penetrated the surrounding paste and produced a cloudy ring. Ground rock temper is often present in the cooking-pot fractures, pieces of cryptocrystalline groundmass, crystals of partially decomposed orthoclase and brown hornblende are conspicuous; flakes of biotite, grains of pale green augite and of titanite are less common (fig. 305, *c*). Mineral inclusions in the paste are the same as those in the cooking-pot sherd temper and were evidently derived from it, as grinding would tend to break out and separate the large mineral inclusions, which are most numerous in specimens tempered with sherds of coarse texture.

Temper derived from sherds of non-culinary ware is recognized by characteristics of the paste. Particles are gray, light brown or light olive, often being nearly indistinguishable from the body paste, some matching so perfectly that they are detected only in polarized light because of differences in orientation of the clay flakes of which they are composed. Mineral inclusions in the non-culinary sherd temper are fine and sparse. They include quartz, feldspar, biotite, pale green mica and zircon. In some sparingly tempered specimens, clay lumps characterized by finer texture and well rounded rather than angular outline are more numerous than sherd fragments. Inclusions of limestone or marl are rare.

A distinct variety of Crackle type contains large irregular grains of magnetite, which preponderate over the colorless minerals. There are few potsherd fragments in these specimens, but clay lumps are often conspicuous. Sand temper was found in one sherd having typical Crackle finish. The temper is mineralogically distinct from the silt or fine sand in Blue-gray type, since it contains clear feldspar in excess of quartz, and numerous fragments of brown hornblende; flakes of pale green mica and biotite and small crystals of zircon are abundant. Grains are subangular and well assorted.

Texture. There is considerable variation in grade and amount of temper. Average grain size—0.14 mm. in diameter; range in average for sherds—0.08 to 0.17 mm. in diameter. The maximum grain size in the majority of sherds varies from 0.48 to 0.56 mm. in diameter; exceptional fragments are 1.28 mm. in diameter. Average grading: very fine—54.4%; fine—33.4%; medium—8.8%; coarse—3.0%; very coarse—0.4%. Sherds differ greatly in the amount of temper which they contain, and although intermediate types occur, the majority are either sparsely or heavily tempered. The average *volume of temper* in the sparsely tempered specimens is 14.8% and the range, 12.4 to 17.4%; in heavily tempered specimens the average is 32.7% and the range, 26.0 to 37.0%. Sixty-eight to 80% of the temper is potsherd, the remainder, mineral matter. Mineral inclusions make up one-third of the total temper in sherds containing magnetite, of which 77 to 87% is magnetite itself.

Clay is olive or yellowish gray in transmitted light. The lighter-colored clay is birefringent and exhibits slight orientation of particles; the darker types are

isotropic or weakly birefringent. Refractive index—between 1.549 and 1.553. The clay is less cloudy in appearance than that of Blue-gray type and is often finely crazed.

Physical properties. *Color* is within the range of Neutral Grays and 15′′′′′, but Crackle is distinguished from other Pecos Black-on-white types by a whitish paste and by conspicuous core-margin variations; in cross-section a dark central zone contrasts with whitish borders. Cores are 15′′′′′ to 15′′′′′i (Mouse Gray to Deep Mouse Gray) and margins, *f* tints or paler. The majority of pastes which are uniform in color are either 15′′′′′b to 15′′′′′d (Light to Pale Mouse Gray) or Carbon Gray 10. Oxidized at 850° C. for 30 minutes—15″d to e (Light Pinkish Cinnamon or slightly paler). Refired to 1200° C.—15″b to 17″b or 13″ (Pinkish Cinnamon to Cinnamon-Buff or Orange-Cinnamon). *Hardness*. The majority of sherds—4. Refired to 1200° C.—7. *Modulus of Rupture*. Average—123 kg. per sq. cm.; range—98 to 155. *Strength of Vessel Walls*. Average—24 kg. per 2.5 cm.; range—16.3 to 28.0. *Apparent Porosity*. Average—24.1; range—16.8 to 31.9%. Refired to 1200° C. Average—11.4%; decrease—50.3%.

Slip. One-third to one-half the specimens are slipped on the exterior as well as the interior. *Color*. 17′′′′f (Pale Drab-Gray) to 21′′′′f (Pale Smoke Gray) and whiter, a few specimens 17′′′′d (Drab-Gray). Oxidized at 850° C. for 30 minutes—15″b to e (Pinkish Cinnamon to paler than Light Pinkish Cinnamon). Refired to 1200° C.—17′′b (Avellaneous), 9″i (Cacao Brown). *Hardness*. 4.5 to 5.5, rarely 4. Refired to 1200° C.—6 to 6.5. *Thickness*. 0.03 to 0.04 mm.; exceptional specimens are 0.14 mm. *Finish and Wear*. Typically well smoothed with horizontal strokes and frequently uniformly lustrous, but some specimens are dull and slightly uneven. Often deeply crazed but very rarely abraded. *Optical Properties*. Clay is gray or light brown in transmitted light, whitish in reflected light. Refractive index—1.549 and 1.553. The light brown clay is weakly birefringent and uniform extinction suggests orientation of particles. It contains a few quartz grains, 0.03 to 0.06 mm. in diameter. The dark gray clay is isotropic, dense, exceptionally fine-textured, free from mineral inclusion and finely crazed.

Paint is organic. *Color* is variable; the darkest specimens are Dusky Neutral Gray *m* or blacker, often with a bloom in streaks of Neutral Gray; grayer specimens are Neutral Gray or 15′′′′′i to m; brownish paints are 13′′′′k to m (Fuscous to Fuscous-Black) or 17′′′′k to m (Chaetura Drab to Chaetura Black). Oxidized at 850° C. for 30 minutes—15′′′′′ to 15′′′′′i. Luster varies with polish of the slip. There is a decided blurring of the outline on some specimens. The paint penetrates the slip completely.

Firing. The birefringence of clay is unchanged by firing to 850° C. but becomes distinctly weaker at 900° C. Paste colors indicate a variable firing treatment; dark cores and whitish margins result from partial oxidation of carbonaceous matter, uniform gray from imperfect oxidation, and uniform whitish from complete oxidation of carbonaceous matter. Color range compared with that obtained by refiring proves that the clay was never fully oxidized.

ROWE TYPE[1]

MEGASCOPIC OBSERVATIONS. The paste of Rowe Black-on-white is distinctly sandy as compared with that of Blue-gray. In many specimens, inclusions can be recognized with the unaided eye, and the coarsest of these when examined with a 10-power hand lens are seen to be composed of fine grains imbedded in a whitish matrix. Dark lumps of clay and a scattering of coarse grains of sand give the paste a non-homogeneous appearance. The fracture is irregular.

TEMPER. Siltstone or very fine sandstone was found in two-thirds of the sherds examined, the remainder was tempered with fine stream sand. The siltstone and sandstone differ only in grain size and are composed of subangular grains of quartz and feldspar with occasional flakes of pale green mica and rarely grains of magnetite, (fig. 305, *e*). The cementing material ranges from calcite to clay but is most commonly marl. Sand grains in the paste correspond mineralogically, as well as in size and degree of rounding, to the grains of the siltstone. Particles of the cement or matrix often adhere to these free grains. The principal minerals of the stream sand are subangular grains of quartz and feldspar, the former always preponderating (fig. 305, *d*). The feldspars include microcline, acid plagioclase and microperthite, and a large proportion of the grains show decomposition and sometimes alteration to sericite mica. Biotite, pale green mica, muscovite, bluish green hornblende, tourmaline and zircon, are found in many sherds, the frequency of their occurrence being in the order given. Magnetite and pyroxene are rare. Lumps of unmixed clay are present in the paste of many sherds and numerous in some.

TEXTURE. Average grain size—0.08 mm.; range—0.06 to 1.10 mm. Maximum grain size: sand—0.32 to 0.64 mm.; siltstone fractures—0.96 to 1.92 mm. Average grading: very fine—75.8%; fine—22.6%; medium—1.6%. *Volume of temper:* average —30.8%; range—24.5 to 37.6%. In sherds tempered with siltstone, 20 to 40% of the total non-plastic material is siltstone.

CLAY. Olive to dark gray in transmitted light, isotropic or very weakly birefringent. Refractive index—1.553 to 1.560.

PHYSICAL PROPERTIES. *Color.* Core-margin variations are found in two-thirds of the sherds. Cores, 15″″″f (Pallid Mouse Gray) or Neutral Gray, are often paler than the margins, which are 15″″″ to 15″″″i (Mouse Gray to Deep Mouse Gray) or 21″″d (Smoke Gray). Margins of 15″″″ are sometimes separated from a Neutral Gray core by a narrow band of 11″i (Pecan Brown). Sherds uniform in color are 21″″ to 21″″d (Grayish Olive to Smoke Gray) or 15″″″a to b. Oxidized at 850° C. for 30 minutes—15″ (Cinnamon). Refired to 1200° C.—9′k (Kaiser Brown) or 7″k (Cameo Brown). *Hardness.* 4 or 4—, a few specimens 5. Refired to 1200° C.—4, rarely 6. *Modulus of Rupture.* Average—103 kg. per sq. cm., range—81 to 143. *Strength of Vessel Walls.* Average—25 kg. per 2.5 cm.; range—18 to 36. *Apparent Porosity.* Average—27%; range—24 to 31%. Refired to 1200° C.—27.4%; increase 0.01%.

[1] Described by Mr. Amsden (Vol. I, p. 26) as a subtype of Crackle under the name of Late Crackle.

Slip. *Color*. 17″″d to f (Drab-Gray to Pale Drab-Gray), occasionally paler than 17‴f (Tilleul-Buff). Oxidized at 850° C. for 30 minutes—15″d (Light Pinkish Cinnamon). Refired to 1200° C. it is absorbed by the paste, except under paint lines where it is 17‴f or paler. *Hardness*. 4. Refired to 1200° C.—5. *Thickness*. 0.02 to 0.08 mm. *Finish and Wear*. Horizontal smoothing strokes are noticeable on the interior but the slip is not lustrous. Exterior slip is thin, streaked and unsmoothed. Slips are frequently badly abraded but not crazed. *Optical Properties*. The clay is dark to medium olive or gray in transmitted light, light yellow in incident light; isotropic or weakly birefringent. Refractive index between 1.549 to 1.553. Contains numerous angular grains of quartz, 0.01 to 0.02 mm. in diameter.

Paint is organic. *Color* is in the range of 15″″ and Neutral Gray; intensity generally *i*, typical, often streaked with *b*; darker specimens are *k*, rarely *m*. Oxidized at 850° C. for 30 minutes—15″″ or slightly paler. It is seldom highly lustrous and penetrates the slip completely.

Firing. Mineral indicators not found. Atmosphere variable as shown in core-margin color variations but paste was never completely oxidized.

BISCUITOID TYPE

Megascopic observations. The paste appears fine and homogeneous. The fracture is characteristically straight and at right angles but occasionally irregular and diagonal. A peculiarity of texture resulting from shape and arrangement of inclusions is noted in some specimens. A sherd of this type, if broken in a direction corresponding to the vertical—top to bottom—of the original bowl, shows, instead of the usual earthen texture, a parallel ridging of the clay. A horizontal break follows an oblique plane and the fractured surface is relatively smooth. Inclusions large enough to detect with a 10-power lens occur in less than half of the sherds and then only sparingly. Opaque white flecks (particles of tuff) and sand grains may occasionally be seen. Black specks or minute craters, surrounded by black rings, are caused by organic matter in the clay.

Temper. All Pecos sherds examined (98) are tuff tempered. Several different kinds of tuff are found; in the majority of specimens the texture of tuff is similar to that in Blue-gray tuff-tempered sherds: common forms are flowage flakes, short stubby rods, together with forked and lunar forms from bubble rims of a coarsely vesicular tuff which was broken either by natural agencies when the tuff was deposited or by the potter in preparing the material. An unusual kind of tuff has been found so far only in Biscuitoid. It is composed of very thin plates of irregular, angular outline. The glass is light brown in color, shows no flowage lines and rarely bubbles, but a fine network of cracks is often seen. Viewed edgewise in cross-section, these flakes have the appearance of slender needles or spicules with colorless margins and brown central streaks (fig. 306, *d*). They are often oriented in parallel position, and a section cut normal to that in which the flakes are edgewise shows mainly the faces of plates (fig. 306, *c*). Sherds of 21‴f (Pale Olive-Buff) paste contain large flakes with very distinct flowage lines and coarse fragments of vesicular tuff which

appear to have been derived from primary deposits (fig. 306, *b*). It is principally these large pumiceous particles which can be detected by the unaided eye.

Mineral inclusions are sparse. A scattering of quartz and unaltered feldspars occur in all specimens. A few particles of hornblende (generally brown, occasionally blue-green) biotite, muscovite, and calcite are found in most sections; small grains of zircon, titanite, augite, and magnetite are of rare occurrence.

Texture. Tuff particles in the majority of specimens are from 0.06 to 0.16 mm. in diameter. The largest fragments of vesicular tuff are 0.5 mm. in diameter. Flakes of the platy tuff vary from 0.16 to 0.32 mm. in diameter and from 0.008 to 0.016 mm. in thickness. *Volume of temper* cannot be determined by the Rosiwal method or by rational analysis, but judging by appearance in thin section the amount of tempering material in most Biscuitoid sherds is no greater than the average of tuff-tempered Blue-gray sherds though the latter show greater variation.

Clay. Light brown in transmitted light, brightly birefringent. Simultaneous extinction of irregular patches, giving a stranded appearance, particularly in areas immediately adjacent to inclusions, suggests similar orientation of lamellae of clay. Refractive index is variable—1.549 to 1.535; 21‴f paste—1.524.

Physical properties. *Color*. 21⁗d (Smoke Gray) and 17⁗f (Pale Drab-Gray) are characteristic. Core-margin variations are uncommon; occasional sherds have either core or outer zone of 15⁗d to f (Pale to Pallid Mouse Gray) combined with the typical color. The same paste, therefore, fired to either 21⁗d or a tint of 15⁗ depending upon firing conditions, but 21⁗d is by far the more common. Color variations are 17‴ (Wood Brown) and 13‴ (Fawn Color); both may have margins of 21⁗d or 21⁗f. A distinct and exceptional paste is 21‴f (Pale Olive-Buff). Oxidized at 850° C. for 30 minutes—15″ (Cinnamon), occasionally 13″ or 17″ (Orange-Cinnamon or Clay Color). Refired to 1200° C.—9′m (Carob Brown) or slightly lighter. *Hardness*. Typically 3.5, rarely 4. Unslipped and unpolished surfaces are the same as the paste. Refired to 1200° C.—7+. *Modulus of Rupture*. Average—123 kg. per sq. cm.; range—102 to 160. *Strength of Vessel Walls*. Average—25 kg. per 2.5 cm.; range—14.0 to 33.0. *Apparent Porosity*. Average—31.2%; range—27.4 to 37.9%. Refired to 1200° C. Average—8.1%; decrease—74%.

Slip. The majority of sherds are slipped on the interior, but as the slip is thin and frequently the same color as the paste, it can seldom be recognized megascopically. Exterior slips are rare. *Color*. 21⁗b (Light Grayish Olive), 17⁗b (Light Drab) to 21⁗d (Smoke Gray); rarely 15⁗. Oxidized at 850° C. for 30 minutes—15″ (Cinnamon). Refired to 1200° C.—9″i to 11″i (Cacao Brown to Pecan Brown). *Hardness*. 3.5, occasionally 3 or 4+. Refired to 1200° C.—7+; usually finely blistered. *Thickness*. 0.03 to 0.05 mm. *Finish and Wear*. Very well smoothed with horizontal strokes, and highly lustrous; never crazed but occasionally abraded. *Optical Properties*. Clay is light to dark brown in transmitted light, pale yellow in reflected light, brightly birefringent and particles are oriented. Refractive index 1.541 to 1.546. Very fine textured and free from mineral inclusions.

Paint is organic. *Color*. Dark Neutral Gray *k* and Dusky Neutral Gray *m*, with streaks and patches of Neutral Gray and Deep Neutral Gray *i*, occasionally blacker than Dusky Neutral Gray, or 15⁗i to m. Oxidized at 850° C. for 30 minutes

—15′′′′′. Uniformly and highly lustrous. Often penetrates through the slip into the paste, in extreme instances to a depth of 0.16 mm.

Firing. The clay of 74% of the sherds examined is birefringent; when fired to 850° C. the birefringence becomes weaker and at 900° C. the clay is isotropic. Calcite was found in 37% of the sherds examined. Paste color indicates that firing conditions were never fully oxidizing.

INTERPRETATION OF TECHNOLOGICAL DATA

The Black-on-white ware of Forked Lightning Ruin and of Pecos has been classified and described by Mr. Amsden.[1] Technological analysis shows that the pastes of the types recognized by him are even more distinctive than the surface characteristics upon which his classification was primarily based. With one exception, the nomenclature originally applied has, therefore, been retained, and although different kinds of tempering material have been found in what otherwise appear to be homogeneous types, and the archaeological significance of certain types has been reinterpreted, this does not seem to justify the multiplication of names or formal subtypes.[2] It is clear, however, that emphasis upon exterior finish has tended to confuse the relationship of types and increased the difficulty of classification. Although well finished and slipped exteriors are characteristic of some Pecos types, while rough exteriors greatly preponderate in others, there are exceptions in all types; moreover, the fact that two types have similar surface finish does not necessarily indicate direct relationship. Pecos Black-on-white ware and that of the entire Upper Rio Grande province to which it belongs are examples of a generalized ceramic style in which sharp subdivisions are difficult to make. The external features of one style grade almost imperceptibly into those of another, for they reflect the potter's attempt to imitate, as well as her skill and inventiveness, or conservatism, nor is there anything inherent in form, surface finish, or decoration to prevent very gradual transitions and various recombinations. Materials, however, remain distinct; sand temper cannot grade into tuff or either of these into potsherd, while each preserves a record of the environment as well as the customs of the potter. Consequently, in the final analysis of this group, tempering material is probably one of the best means of localizing types and of determining the immediate influences which contributed to their development. Identification of materials also makes possible the classification of the "borderline" pieces which are often very numerous among sherds of this class and which confuse the relationships and proportions of types. Sherds from stratigraphic tests at Forked Lightning and Pecos have, therefore, been studied microscopically and classified independently on the basis of technological features in order to trace in some detail the ceramic history of the Black-on-white period at Pecos. But before considering stratigraphic occurrence, a brief review of the characteristics of types will serve to bring out the principal differences and explain the basis of classification.

[1] Vol. I, pp. 23-26.

[2] For a working synonomy permitting comparison with Mera's types, see p. xxx.

Blue-gray is a generalized type lacking color contrast and fineness of execution. The paste is characteristically fine-textured, soft and friable, and its color is largely limited to the range of 15''''' (Mouse Grays) and Neutral Grays with color variations in any given sherd exceptional. Surface finish is variable. A slip usually lighter in color than the paste was generally applied on bowl interiors, though a few are unslipped. Slips are characteristically thin and uneven. They are usually soft and often become rubbed and patchy with wear. Bowl exteriors are typically neither slipped nor polished, and the texture is finely earthen as left by the shaping or scraping process. Rarely the exterior was slipped. The organic paint used for decoration fired light to dark gray, occasionally approaching black on some of the thicker, creamier slips. Three distinct kinds of inclusions, silt, tuff, and sherd, are found in Blue-gray sherds, but the texture of each is so fine that the pastes cannot be distinguished megascopically and the varieties appear superficially identical. The majority of Blue-gray sherds contain silt or very fine sand. These inclusions are so fine and sparse that it seems probable they occurred naturally in the clay, which may have been sufficiently "short" or sandy for the potters to use without the addition of temper. The inclusions are mainly too fine to be classed as sand, only 16 to 18% of the grains exceeding 0.1 mm. in diameter, which is 0.1 to 0.2% of the total volume of the paste. In comparison, the finest material the writer was able to collect from the Arroyo del Pueblo is composed of 93% sand. A typical Sikyatki Polychrome sherd, representative of a ware made from untempered clay, was found by count to contain 11.9% of inclusions, but no single grain over 0.1 mm. in diameter. Clays carrying as much silt as that in Blue-gray paste are common in the region in which this type is found and while there exists between sand-tempered and untempered paste a borderline in which the material may either have occurred naturally in the clay or have been added by the potter, it is exceedingly unlikely that material so fine and in such small quantity as that in Blue-gray would have been added by the potter. Textural difference between this subtype and one tempered with fine sand is shown in figure 305, *a*, *d*. The variety of Blue-gray containing silt will, therefore, be referred to as untempered. A few sherds were found, however, which were definitely sand-tempered and a finely micaceous paste variations was also noted. These variations never reached 10% of the total Blue-gray sherds.

Tuff-tempered Blue-gray sherds are found throughout the deposits in which this type occurs. They make up from 12 to 40% of the Blue-gray sherds in Forked Lightning stratigraphic tests and from 30 to 80% of those in Pecos tests. The tuff temper of different sherds varies in texture and mineral inclusions. Textural variation may be due in part to the thoroughness with which the material was pulverized before use, but in some instances divergences are such as to suggest a different source of tuff. Mineral inclusions were probably introduced principally with the tuff. Texture and mineral inclusions may, after sufficient field work has been done, make possible the exact location of the source of tuff temper. Although the paste of tuff-tempered and untempered Blue-gray sherds appears identical to the naked eye, analysis brings out certain constant differences. The tuff-tempered sherds are slightly more porous, averaging 3.5% higher in porosity. Optical properties of some of the pastes and slips differ. Fine lumps of marl are typical of the paste of untem-

pered sherds, while they are of sporadic occurrence in the tuff-tempered variety. As each was subject to the same conditions after discard, deposition of lime from soil water would be the same in each and the shape and uniform distribution of the marl lumps indicate that they occurred with the clay. Hard lumps of clay are also much more common in untempered than in tuff-tempered sherds. Their presence may be due to the potter's carelessness in preparing the clay and her failure to reject hard granules which were not readily softened in water. Clay deposits are sometimes seamed with veins of harder or differently colored clay, which may also partially explain the characteristic occurrence of clay lumps in these sherds.

The third or sherd-tempered subtype of Blue-gray was not included with the type material submitted for study, but showed up in the early Forked Lightning cuts in significant proportions. The potsherd temper is ordinarily too finely ground to be visible even with a 10-power lens. Microscopically the sherd fragments are easily distinguished from well rounded clay lumps by their irregular, angular outline. But the subtype is not easily confused with Crackle type Black-on-white as the latter has distinctive paste and finish, whereas the paste and surface of the former mark it at once as Blue-gray.

Crackle type Black-on-white is technologically very different from Blue-gray. The clay is carbonaceous, but under the best firing conditions approaches white. Sherds with dark cores and nearly white margins are common, though a uniform gray paste also occurs. The paste is harder, stronger, and less porous than that of Blue-gray. When refired it burns to buff instead of the deep red brown of Blue-gray, and it is also more refractory than the latter. While the clay of the paste is firm and dense, the inclusions are coarse and potsherd temper can be detected megascopically in approximately half the sherds. After examining a quantity of specimens in thin section, one is impressed by the variety of sherds ground for tempering. Pieces from coarse black culinary pots were used along with those from Black-on-white ware, and there was clearly no attempt to select fragments from particular wares as has been noted among modern Zuñi potters.[1] Mineral inclusions, and sometimes fractures of rock, are present in the paste. They are usually identical in character with inclusions in the fragments of sherd temper and it is more likely that they were derived from them than that sand or rock was intentionally added by the potter. When potsherds were ground for tempering material, the coarse mineral and rock particles in the paste would tend to be broken out and separated from the clay. It is significant that mineral inclusions are most numerous in sherds containing coarsely-tempered sherd inclusions. Certain of these mineral inclusions give important evidence of sources of origin. A curious variation of Crackle paste contains large irregular grains of magnetite which are more numerous than the colorless mineral, and sherd fragments are sparse or absent. All other chracteristics remain the same. As magnetite is often separated in stream beds, because of its high specific gravity, it might easily be gathered from this source, but it is difficult to understand the

[1] Dr. F. W. Hodge in a personal communication states: "During the excavations at Hawikuh, Zuñi women often examined our discarded sherds and I frequently observed that they preferred the oldest fragments, especially Black-on-white, always rejecting the cooking-pot sherds as unsuited to their purpose."

reason for its selection. The hard black particles are conspicuous in the white paste, but may be mistaken for black sherd fragments, and if any doubt exists it is advisable to separate them and determine whether or not they are magnetic.

The slip of Crackle is harder than that of other Pecos Black-on-white types, seldom shows wear, and is almost always well polished and frequently crazed. The majority of bowls are slipped and polished on the exterior as well as the interior. Crackle is perhaps the most specialized of Pecos Black-on-white types and is definitely superior to the others in quality of surface, color, and hardness of paste and slip.

Biscuitoid has many resemblances to Blue-gray and may be regarded as a late, specialized form of the type. The paste is so fine-textured that tempering material can rarely be seen, even with a 10-power lens. But Biscuitoid sherds from Pecos are all tuff-tempered and tempering material does not, therefore, distinguish the type from a portion of Blue-gray sherds.[1] Differences between the two types are not as sharp and clear cut as between others, but there are certain characteristics, due largely to quality of paste, which, though not invariably constant, nevertheless distinguish Biscuitoid. The paste and slip are typically 21″″d and b (Smoke Gray and Light Grayish Olive) in contrast to the Mouse Grays and Neutral Grays of the Blue-gray type. The streaked whitish slips common in Blue-gray do not occur in Biscuitoid, the surfaces of which resemble the paste in color, the differences being of the order of those existing between porous and compact material. Biscuitoid was either slipped with the same clay used for the body, or the unslipped surface was very well smoothed. The surface in thin section shows a distinct outer layer which differs from the paste primarily in the more complete orientation of clay particles. The interiors of Biscuitoid bowls were exceptionally well polished. The surface is usually recognized by touch as finer and smoother in texture than that of Blue-gray and it seldom shows wear or abrasion. Occasionally the exterior has the same high polish as the interior, but in the great majority of sherds it is unpolished and similar in texture to the exterior of Blue-gray, sometimes having been very finely striated by a scraping tool. The paint of Biscuitoid is usually darker, more nearly black, than that of Blue-gray. While the greater depth of color may be due in part to difference in firing conditions, the properties of the slip clay are probably the primary factor influencing the quality of organic paint. Mr. Amsden has recorded the considerable thickness of vessel walls,[2] which like paint color, though characteristic, is not to be regarded as an invariable criterion of the type. Biscuitoid paste averages 3.7% higher in porosity than Blue-gray. It often appears more open- or loose-textured and gives an impression of lightness of weight, but it has been found that judgment of weight is not a reliable basis for estimates of relative porosity.[3] The tuff in the majority of Biscuit-

[1] Mr. Amsden (Vol. I, p. 25) thought that some Biscuitoid sherds were untempered and proposed a subtype called Clay ware. But such a variation was not found and the name has been dropped.

[2] Vol. I, p. 25.

[3] The bulk specific gravity of untempered and tuff-tempered Blue-gray and Biscuitoid sherds was found to average 1.77, 1.66 and 1.62 respectively. The weight of sherds 15 cc. in volume, which is a fair-sized sherd, would be 26.5, 24.9 and 24.3 grams for the three types in the order named. It is evident that the difference in tuff-tempered Blue-gray and Biscuitoid could not be detected; neither is it likely

oid sherds is similar in texture to that in Blue-gray sherds but a distinctive and interesting variety is also found. It is composed almost entirely of flat plates. These often assumed a definite arrangement when the vessel was shaped and finished, and their position seems to have been influenced principally by the pressure exerted in welding coils, for the majority of flakes are approximately parallel to the direction of the inside diagonal overlap of coils. When sherds are broken horizontally (parallel to the vessel rim) flat surfaces of plates are exposed (fig. 306, *c*) and the smooth, oblique fracture follows the coil junctures; while in a vertical break the plates are in edgewise position (fig. 306, *d*) and consequently the fractured surface shows a characteristic and peculiar finely ridged texture.

The type named Late Crackle by Mr. Amsden has more technological similarities to Blue-gray than to Crackle. The paste of the first two have the same color range and are soft and friable in contrast to the hard, dense, whitish paste of Crackle. Late Crackle is tempered with sand or siltstone; the sherd temper which distinguished Crackle type is never found in it. The open-textured paste of Late Crackle, produced by temper, may partially account for the frequent core-margin color variations; these are exceptional in Blue-gray. The type has the appearance of a coarsened Blue-gray. The slip is soft, chalky, and scaly and wears badly, but the proportion of sherds with slipped exteriors is nearly as great as in Crackle type. Late Crackle is further distinguished by a large number of flare rims.

Chronological position, exterior slip, and inferior quality of paste and slip led Mr. Amsden to regard this type as a late degenerate phase of Crackle type.[1] As similarities of design are not mentioned, the theory of relationship was apparently based on the frequent application of slip to the outside of bowls. Technological analysis, however, shows very clearly that different clays were used and sherd temper, a diagnostic of Crackle, never occurs in late Crackle. While the slipping of the entire bowl may have been stimulated by the example of Crackle, more than this is necessary to prove direct relationship. Moreover, geographic distribution shows conclusively that the two do not represent a developmental sequence. Late Crackle is a distinctly local specialization which took place at Pecos and in its immediate vicinity, while the center of distribution of Crackle lies west and southwest of Pecos. Particularly important is the fact that Late Crackle is of limited geographic spread and is not found in the center of distribution of Crackle. The naming of every local variation is unnecessary and may be responsible for error and confusion, particularly when such classification precedes exact description. Late Crackle might logically be considered a coarsened variant of Blue-gray which is

that the difference of 2.2 grams between untempered Blue-gray and Biscuitoid would be recognized, for sherds compared usually differ both in size and thickness and are never of exactly the same volume. This comparison is of averages; the relation of extremes in bulk specific gravity of the three types is similar to that shown by their averages. The weight of the most dense Blue-gray sherd, 15 cc. in volume, and of the most porous Biscuitoid of the same volume would be 27.6 and 22.5 grams respectively. In extreme cases therefore the tuff-tempered type might be distinguished from the untempered, but we are not concerned with extremes only, or with uncertain estimates. Confusion will be avoided if these facts are recognized.

[1] Vol. I, p. 26.

not always easily distinguishable from it. But the fact that it was recognized megascopically as something different suggested that it should be given type status. As the name originally applied conveys an erroneous impression, the term Rowe Black-on-white has been substituted.

The coarse and fine tuff-tempered subtypes of Blue-gray bear somewhat the same relation to each other as Rowe does to untempered Blue-gray, and the surface resemblance of the two coarsened paste subtypes is perhaps best illustrated by the fact that tuff-tempered sherds were included with Mr. Amsden's type specimens of Late Crackle. It may be questioned whether they should not be regarded as a tuff-tempered variant of Rowe rather than a coarsened tuff-tempered Blue-gray, but the reason for the latter classification will become evident upon the discussion of their geographical and chronological positions.

The tempering material in some Rowe Black-on-white sherds is stream sand and in others siltstone (fig. 305, *d*, *e*). In the latter case the abundance of siltstone fractures in the paste, cementing material adhering to free grains, and similarity in their size and grading to those in the siltstone fragments, leave no doubt that siltstone rather than stream sand containing some fractures of siltstone was used. There is no way of determining whether a friable rock was ground for tempering material or some source of disintegrating siltstone, such as is found under weathered ledges, was known. The use of siltstone or very fine sandstone appears, in the light of our present knowledge, to be a peculiarly Pecos trait, and while it is found first in Rowe type it becomes a well established custom in the Glaze period.

The types described above are essentially those recognized by Mr. Amsden and their technological features leave no doubt that they are valid types. However, the curves plotted by him for the occurrence in stratigraphic tests of the rough and polished exterior catagories represent these types only approximately.[1] There are many exceptions in exterior finish, such as Crackle with rough exterior, and Blue-gray with polished or slipped exterior; but since there are nearly as many exceptions in one type as in the other, they practically counterbalance each other. The classification introduces confusion, however, because early subtypes of Blue-gray and Rowe, both unrelated to Crackle, are included in the Smooth Exterior Category, and because Biscuitoid is included with the Rough Exterior Category and thus its range and occurrence are not shown. The two Black-on-white categories are plotted by Mr. Amsden, in their relation to the total sherds; consequently, their percentages and the form of the curve are influenced by fluctuations in the ratio of Black-on-white to culinary ware.

In the microscopic reëxamination of stratigraphic material, four tests were chosen for study: Tests D and VI from Forked Lightning, and Tests XX and XXI from Pecos. Results of the last two have been combined. The location and depth of these tests have been described by Mr. Amsden.[2] Test D is thought to tap the earliest deposits of the site, its uppermost cuts having been laid down not later than middle Forked Lightning times. The upper cuts of Test VI are believed to represent

[1] Vol. I, pp. 28-41.

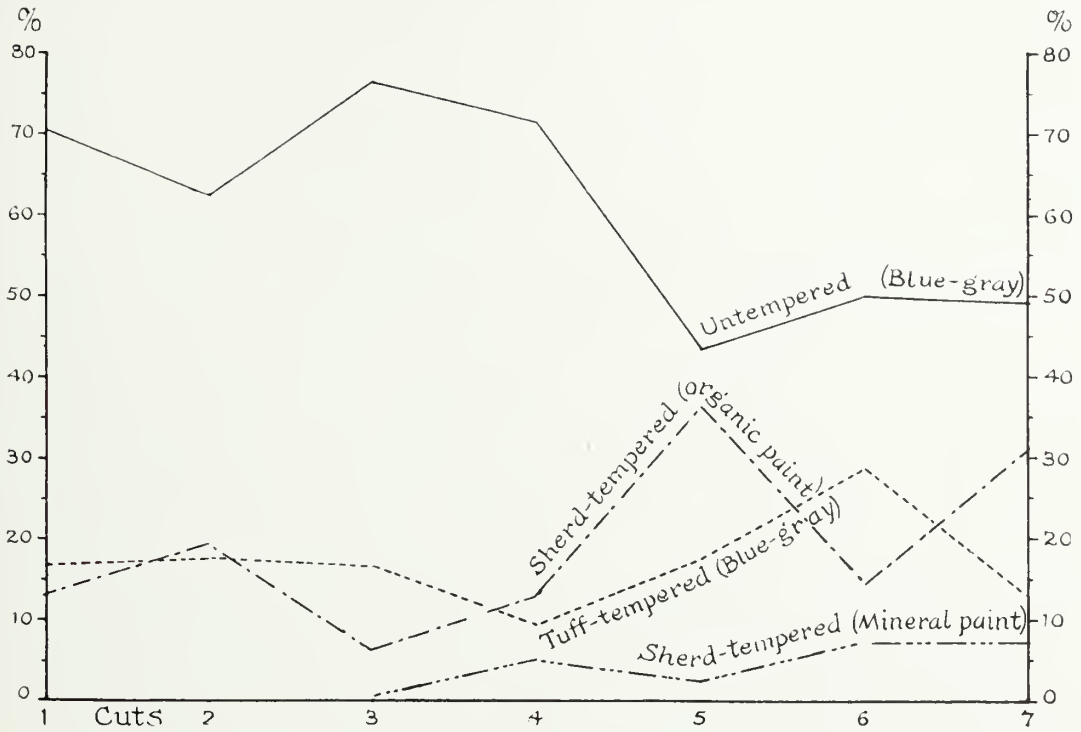
[2] Vol. I, pp. 27-44. The number of sherds in each cut is given in Mr. Amsden's tables.

the latest Forked Lightning deposits, while its lowest cuts reach back presumably into middle period deposits. Whether the uppermost strata of D and the lowest of VI were contemporaneous, or whether there was a time interval between, cannot be determined with certainty, but the difference in percentage of the three principal pottery groups plotted in the top cut of D and the bottom cut of VI is from 7 to 15%, which is well within the range of variations which occur from cut to cut of the same test. It is therefore probable that only a slight gap, if any, exists between the two cuts, and that no important change occurred in the interval which may be unrepresented. When viewed together the two tests show the trend of ceramic development during the occupation of Forked Lightning. Mr. Amsden considered that Cut 1 of Test VI at Forked Lightning and Cut 11 of Pecos Tests XX and XXI represented an almost unbroken sequence, but the more detailed study of the material, with special reference to the difference in percentage of Crackle, the dominant type, indicates that there was a slight gap between the two. This might be expected, for it is hardly likely that the very end of Forked Lightning occupation is represented in Test VI; and Tests XX and XXI may not include the very earliest Pecos refuse.[1] However, allowing a small hiatus between Test VI and Tests XX-XXI, the graphs of the three tests may be viewed end-to-end. They represent a general and only slightly interrupted sequence, showing definite trends and allowing one to follow the first appearance, the dominance, and the decline of types. Many variations which, seen in random lots, are meaningless or confusing, contribute to a fuller understanding of the history of the ware when they can be studied with a knowledge of their true proportions and chronological positions. In analyzing the test material, identification was made primarily on the basis of temper, though surface finish and paste were considered. A classification would not have been attempted without the microscope, for tempering materials are definite substances which do not exhibit the continuous gradations existing, for example, between well polished and rough surfaces. The microscopic determination of temper thus eliminates personal judgment and uncertainty. Another reason for stressing identification of inclusions or tempering material is the fact that some kinds of temper have regional significance.

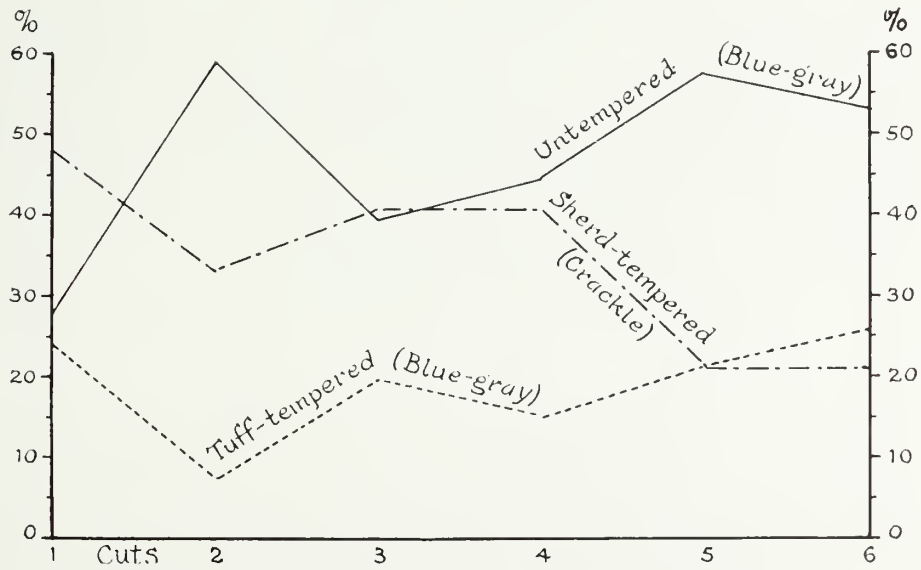
The untempered and tuff-tempered subtypes of Blue-gray have been plotted separately in the graphs which follow. Biscuitoid, which is distinguished from tuff-tempered Blue-gray principally by color and similarity of paste and slip, was also plotted separately. The very minor percentage of sand-tempered sherds found in the Forked Lightning cuts was plotted with the untempered subtype of Blue-gray, since they are identical in other respects. On the other hand, the sand-tempered sherds first appearing in Cuts 8 or 9 of the Pecos tests, belong to the distinct Rowe type and are consequently shown separately. The sherd-tempered subtype of Blue-gray is included in the curve for sherd-tempered types, but after middle Forked Lightning times this curve represents only Crackle and includes, as well as the normal form, that with magnetite grains.

In the earliest Forked Lightning deposits, Black-on-white ware was made up almost entirely of the three subtypes of Blue-gray (see Graph VII, Test D). The

[1] (Note by A.V.K.) I believe that somewhat earlier deposits lie further to the west, at the foot of a rock ledge that underlies the west side of the Great Quadrangle.

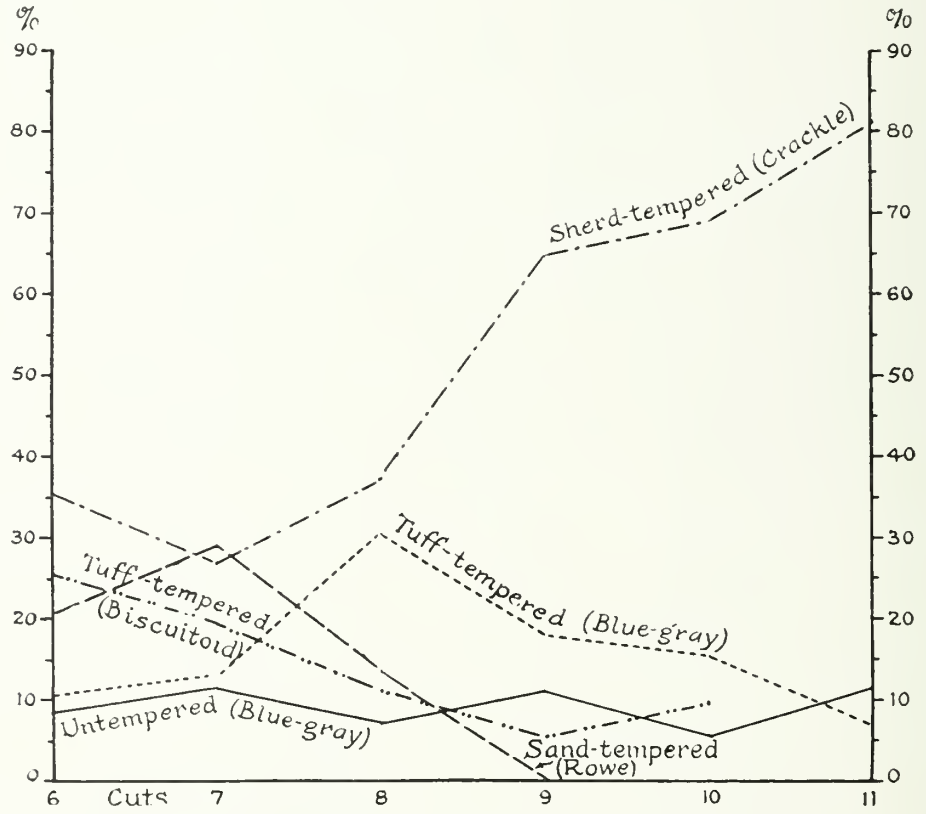


Graph VII. Test D, Forked Lightning. Paste of Black-on-white ware. The line for sherd-tempered paste (organic paint) represents Crackle in Cuts 1 to 3 and Blue-gray in Cuts 3 to 7.



Graph VIII. Test VI, Forked Lightning. Paste of Black-on-white ware.

sherd-tempered subtype held an important place up to Cut 5 of Test D, after which it abruptly declined. Coincident with the decline of the sherd-tempered subtype the untempered form became strongly preponderant and retained this position through Middle Forked Lightning times, while the tuff-tempered subtype maintained a relatively even trend, making up less than a fifth of the total Black-on-white sherds. The sherd-tempered group is proportionately lowest in Cut 3 and in this cut the first distinctive examples of Crackle type are found; therefore when Crackle first



Graph IX. Tests XX-XXI, Pecos, combined. Paste of Black-on-white ware.

came in, untempered Blue-gray had reached its peak. At the beginning of Test VI (see Graph VIII) untempered Blue-gray is still the principal type, but gradually becomes less abundant, while Crackle type (now represented by the curve for sherd-tempered pottery) commences a steady rise, approximately equalling untempered Blue-gray in Cuts 4 and 3 and superseding it in the uppermost cut of the test. The reason for the temporary rise in untempered Blue-gray in Cut 2 is not evident, but for some reason both Crackle and tuff-tempered Blue-gray dropped below the average in this layer. If the two subtypes of Blue-gray, i.e. untempered and tuff-tempered, had been plotted as a single line a more even curve would have been

obtained and a less interrupted decline have been shown. Tuff-tempered Blue-gray constitutes approximately a tenth to a quarter of the Black-on-white ware in Test VI, but there is no marked or consistent chronological change in the proportion of the subtype. In the Pecos tests (Graph IX) the trend which was observed at the end of Test VI has reached its climax; Crackle type is present in overwhelming majority; and Blue-gray, both tuff-tempered and untempered, occurs in insignificant, and for the first time, nearly equal amounts. After the lowest cut, Crackle type declines, though remaining in the majority until almost the end of Black-on-white times. Untempered Blue-gray lingers on, represented by only a few sherds and was possibly no longer being made during the time represented by the last few cuts in which it is found. Tuff-tempered Blue-gray, on the other hand, increased until in the eighth cut it reached almost a third of the total Black-on-white ware. Coincident with this rise in tuff-tempered Blue-gray, two new types appear: first Biscuitoid, then Rowe; and by the last cut in which there are sufficient sherds to record proportions, the two had reached a fifth and nearly a third respectively of the total Black-on-white ware.

During the period represented by these graphs, some types show gradual modifications in technique, others are variable throughout, and still others seem to have been standardized. Untempered Blue-gray is the most uniform in paste color and texture, as might be expected from the use of clay alone; but in the first few cuts of Test D there is a wider color range, and pale grays and core-margin variations are found. In Test D, Cut 4, when the type was reaching its peak, these paler pastes are no longer present. Though the type is characterized by a thin, soft, gray slip, bowls were not slipped with equal care and there is a slight progressive change in finish. Some bowls with unslipped interiors are found throughout Test D, the proportion being as high as 21% in the lower cuts and dropping to 13% in Cut 1, and they are of sporadic occurrence in Test VI. A few bowl sherds with slipped exteriors are found in all periods, the percentage increasing slightly but steadily in Test D from 2 to 9%; in the lowest cut of Test VI it is 13%, but drops abruptly and remains from 2 to 4% of the total Blue-gray sherds. The largest proportion of slipped exteriors in Blue-gray is accordingly not found when the type was at its peak, though it was still preponderant, and Crackle type was just becoming established. It is questionable whether the finish of the type was influenced by Crackle, for as the latter became more abundant, Blue-gray was less often slipped on the outside; furthermore, during the entire period in which Blue-gray was made, the number of sherds with slipped exteriors shows that they simply represent the occasional attempt of the potter to make a particularly fine piece. Rarely a sherd of this type is painted as well as slipped on both interior and exterior.

Sherd-tempered Blue-gray does not cover a sufficiently long period (i.e. Cuts 7 to 3, Test D—see Graph VII) to show important changes, but the tuff-tempered variety exhibits not only the same differences in surface as the untempered form, but also some change in the kind of tuff used. The majority of sherds contain small flakes with flowage lines, and irregular, lunar and forked forms, largely from broken bubbles, similar to that shown in figure 306, *a;* but in the Pecos test cuts in which tuff-tempered sherds are most numerous there appears a coarse variety easily

identified by the unaided eye, for the paste is thickly peppered with pumiceous particles and phenocrysts, the largest of which are a millimeter or more in diameter (fig. 306, *e*). This coarse-tempered variety appears abruptly and makes up 51%, 92% and 91% of the tuff-tempered Blue-gray sherds in Cuts 9, 8, and 7 respectively of Tests XX-XXI. With the exception of one sherd in Cut 6 of Test XXI, the coarse-tempered variety was not observed in any other cut.

Biscuitoid, though having a comparatively short span, also exhibits differences in the character of tuff temper. Particularly noticeable is the increase in the amount of platy tuff in the latest cuts; the proportion in Cuts 9, 8, 7, and 6 being 10, 10, 27 and 66% respectively. There is no noticeable change in the finish of the type.

Crackle is technologically the most variable and in many respects the most interesting of the Black-on-white types. The color and density of paste, coarseness and composition of temper, hardness of slip and proportion with slipped exterior are all variable, some showing definite chronological significance, others apparently meaningless fluctuations. The grain size of the sherd temper varies within wide limits; in some sherds it is too fine to be identified with certainty with a 10-power hand lens, while others contain fragments a millimeter or more in diameter. In Test VI the proportion containing sherd particles which can be recognized by the unaided eye ranges between 34 and 50%. In Test XXI it is 62% in the lowest cut, at the peak of Crackle development, and thereafter declines steadily. The paste with conspicuous grains of magnetite is present from the first but of erratic occurrence in Test D (9 to 25%), higher in VI though still variable (16 to 65%), lower in the earliest cut of Tests XX-XXI (42%) and subsequently unimportant (6 to 9%). The dense pale gray to whitish paste which is distinctive of Crackle is found in from a quarter to a half of the Crackle Sherds in Test VI, while three-quarters of the sherds in the lowest cut of the Pecos test are of this paste; but after that the proportion decreases progressively to a quarter at the end of the period. The custom of slipping the exteriors of bowls is especially associated with Crackle type, but the proportion of slipped exteriors is low, 12%, in the earliest cut of Test VI; in subsequent cuts it is from 40 to 65%. The average for the Pecos tests of Crackle sherds with slipped exteriors is 50%, though it is somewhat higher in the late cuts (77% in Cut 7 and 68% in Cut 8). From a fifth to a third of the unslipped exteriors were polished, and no chronological change is shown in the proportions. The quality and hardness of Crackle slip differ noticeably; the differences are explainable by the use of more than one slip clay rather than by variations in firing temperature. A hard slip (5.5 to 6 in Mohs' scale) takes a good polish, is crazed in from 40 to 60% of the specimens and never peels or shows abrasion. The soft slip (4 to 4.5 in hardness) does not have as high a luster, is rarely crazed, but often badly worn. These two slips differ noticeably in appearance and can be distinguished in an instant by scratching with a file, as the soft slip is easily scratched, the hard one barely marred. In Test VI the proportion of hard slip is from 42 to 80% of the total Crackle and in Test XXI from 80 to 50% with a progressive decrease. The majority of sherds with hard slip have the coarse-tempered, dense, whitish paste in contrast to the soft slip variety which is more often of friable gray paste. There is also a slightly higher proportion of slipped exteriors in the former class. In general, features (i.e. white paste, medium to coarse

sherd temper, and hard crazed slip) which characterize specialized Crackle are of variable occurrence in the Forked Lightning material, which perhaps represents a formative stage; while near the beginning of Pecos occupation, when the type is at its peak, these are in the highest relative proportions and then decrease gradually. The proportion of exterior slips is one exception to this statement, for it increases slightly to the end.

It would be interesting to know whether there is any change in proportion of exterior slip, flare rims, and siltstone temper in Rowe type, but there are too few sherds and insufficient range in Tests XX-XXI to determine percentages.

The stratigraphic tests reveal a surprisingly complex condition existing at Pecos during Black-on-white times, for the tangled curves on these graphs represent fundamental differences in potters' materials and not simply variations in the minor features of a ware. The curves are not erratic, but show distinct rises and declines and entirely normal forms. The occurrence of pottery with the same form and style of design yet basically different clay and non-plastic inclusions raises problems of origin and sources of influence. Particularly interesting is the contemporaneous occurrence throughout the period, and in some instances even in the same type, of three distinct kinds of tempering material. Pecos was not an isolated community and the course of its ceramic history can fully be understood only when it is studied in relation to neighboring communities and culture areas. Comprehensive stratigraphic material from the Upper Rio Grande area is not at present available for study, but surface specimens from various sites have been examined to gain a general, if sketchy, picture of distributions. These observations are recorded only because they suggest possible explanations of the condition at Pecos and define more specifically problems for future investigations.

Blue-gray and Crackle differ in geographic distribution.[1] Though of wider distribution, Blue-gray is the characteristic Black-on-white type of the section of the Rio Grande Valley from the Tesuque Valley on the south to the confluence of the Chama with the Rio Grande on the north. The area includes the Pajarito Plateau on the west and the tributary valleys of the Rio Grande to the foothills of the Sangre de Cristo on the east. In this area Crackle sherds are rarely found, their center of distribution being the Galisteo Basin southwest of Pecos. Sites in the region between the Rio Grande and Galisteo centers contain various proportions of the two types and Blue-gray is also found in Galisteo sites. The geologic features of these two areas are distinct, and the pottery types reflect in their composition some of the differences in formations. The formations of the Rio Grande Valley section are principally Tertiary sandstone and marls, and red-burning, alluvial clays abound. On the west is the great volcanic crater of the Jemez Range with its bordering plateaus of rhyolite tuff. Deposits of wind-blown and water-laid tuff are also found in the valley sediments. The Galisteo Basin is an area of Cretaceous sediments. Carbonaceous buff-burning clays are to be found near the sites, which are mainly located on the margins of the basin. The area is bounded on the west by a line of

[1] Mera, 1935, maps the distribution of pottery comparable to these two types under the names "Santa Fe" and "Galisteo" respectively.

low mountains, the San Pedro, and Ortiz, and the Cerrillos Hills, composed of intrusive igneous rock of intermediate composition. Dykes radiate from these mountains into the basin, and the presence of igneous rock influences the composition of sand in the streams of the western drainage. Fragments of the rock are found in various pottery types of the region, just as volcanic ash is common in many of the types from the Rio Grande Valley.

Referring then to the graphs of Pecos Black-on-white types, it is clear that both these areas influenced Pecos during this period, first the Rio Grande Valley and then the Galisteo Basin being dominant. A detailed examination of the ware raises the question as to what extent similarities result from potters following the same methods and patterns, and to what extent trade may be responsible for the occurrence of identical pottery types in distant pueblos located in geologically distinct provinces. The presence of tuff temper in a portion of Blue-gray sherds throughout the Pecos refuse formulates the problem very definitely. Here are sherds from bowls which were shaped, finished, and apparently decorated in the same manner. To the naked eye there is no difference between them, yet one is made from untempered clay, while for the other volcanic ash was intentionally mixed with the clay. The nearest deposits of tuff are some thirty miles by trail from Pecos. It seems improbable that Pecos potters would go this distance to obtain material for pottery which would not differ in any outward feature from that which could be made from clay obtained within a few hundred feet of their village. If there were advantages in the use of tuff, or if tuff occurred only in the finer vessels, then long journeys to procure it might seem plausible. It is true that tuff sometimes occurs in a much finer state than the other materials commonly used for tempering, and it, therefore, makes possible a smoother surface finish. But a tuff-tempered paste is no smoother than untempered clay; moreover, the potters of those times made no special effort to perfect the surface texture of their pottery. The principal argument against the theory that these tuff-tempered vessels are intrusive is that a much larger volume of trade is indicated than had hitherto been suspected. However, it can be proven in the case of other wares that equally large volumes of pottery were obtained in trade. A portion of the cooking-pots, for example, were obtained from the villages of the Pajarito Plateau during Black-on-white times and in certain of the test cuts they make up 25% of the total culinary ware (see p. 563). In view of this fact it does not seem improbable that the Pecos people obtained a large amount of their Black-on-white ware through trade. If it could be shown that the clay of these tuff-tempered vessels came from the Rio Grande deposits, the evidence for barter would be considerably strengthened. The clay of this subtype, however, is of a non-refractory, red-burning, sedimentary type common to both the Pecos and the Rio Grande. The texture and composition of the tuff, however, show that it came from more than one Rio Grande source: the finer material from sorted secondary deposits in the valley, and the coarse pumiceous material from the tuff of the plateau. This strongly suggests trade in finished vessels, for it is extremely unlikely that the Pecos Indians would go as far as the Pajarito Plateau for tempering material when they knew the far more conventiently located deposits in the valley. While the evidence so far accumulated is not conclusive, it definitely supports the theory of trade. These

tuff-tempered types are, therefore, tentatively considered intrusives and the ceramic history of the pueblo is interpreted in this light.

During the greater part of the Black-on-white period tuff-tempered Blue-gray makes up from a tenth to a fifth of the total painted pottery, but twice rises to nearly a third, once early in Forked Lightning times (Test D, Cut 5) before Crackle had appeared, and again, as a coarse variant, late in the Black-on-white period (Pecos Tests XX-XXI, Cut 8), when Crackle was well on the decline and shortly after the first occurrence of Biscuitoid and Rowe. The proportion of tuff-tempered sherds in the total sherds of Blue-gray type is more interesting. It is higher in the first three cuts of Test D (20 to 40%) than in the remaining cuts of the test (12 to 22%). There is little change in ratio in the four lowest cuts of Test VI, but it is of erratic occurrence in the uppermost cuts of the test, jumping from 13 to 54%. The Pecos tests, which contain what seems to be only a slight holdover of untempered Blue-gray, show the highest ratio of the tuff-tempered variety (average 59%, maximum 81%). The abrupt appearance of pumiceous tuff in the three cuts with the largest amount of tuff-tempered Blue-gray has been mentioned. The tuff of these sherds has the characteristics of that from primary deposits of the main formation, probably the Pajarito Plateau. The reason for its abrupt appearance and high proportion during a relatively short period may be due to changes in method of tempering in the tuff area or to the establishment of trade with a new group of villages. Analysis of pottery from the Pajarito Plateau and the adjacent region should throw some light on the question. Much of the very fine-textured tuff of Blue-gray from Forked Lightning has the characteristics of material from the secondary valley deposits.

The Black-on-white sites of the Upper Rio Grande area differ considerably in proportion of the tuff-tempered subtype of Blue-gray. Results of microscopic examination of sherds from a few sites give some indication of occurrences;[1]

Pajarito Plateau, mesa north of Water Cañon, (L. A. 1757);[2]
100 sherds—100% tuff-tempered.

Tesuque Valley, ½ mile north of Camel Rock, (L. A. 382);
100 sherds—26% tuff-tempered.

Pueblo Alamo, 10 miles southeast of Santa Fe, (L. A. 8);
Buildings I, II, and III; 45 sherds—31% tuff-tempered.
Building IV; 33 sherds—42.5% tuff-tempered.

Arroyo Hondo, (L. A. 12);
Buildings I, II and III; 40 sherds—50% tuff-tempered (35% coarse tuff).
Room VII; 34 sherds—67% tuff.
Room VIII; 45 sherds—62% tuff-tempered.

San Cristobal, (L. A. 80)
Refuse B, Cut 9; 36 sherds—4% tuff-tempered.

[1] Sherds from Pueblo Alamo, Arroyo Hondo, and San Cristobal are from the excavations of N. C. Nelson and were examined through his courtesy and that of the American Museum of Natural History.

[2] Site number of the Archaeological Survey of the Laboratory of Anthropology.

Tuff-tempered pottery was, therefore, quite generally distributed. Some tuff might be expected to occur naturally in the clays and sands of the Pajarito Plateau and its introduction in the pottery would then have been unintentional. But examination of these materials shows conclusively that such was not the case; tuff was not found in the clays examined, while the stream sands differed entirely from the non-plastic material of the pottery in amount of mineral matter and the kind of tuff which they contained. The use of tuff for temper, therefore, was evidently a well established custom. It is curious to find that the proportion of tuff-tempered sherds is apparently no larger in the Tesuque Valley site, within a quarter of a mile of tuff beds, than in sites south of Santa Fe, twenty miles or so from deposits. It is possible that the tuff-tempered and untempered pottery of the Tesuque site are from different periods, rather than that the two kinds were made contemporaneously or that one was obtained in trade. The large amount of untempered pottery in this site suggests the possibility that a portion of the Pecos untempered Blue-gray may have been trade ware also, but a more detailed knowledge of the Rio Grande area is necessary before comparisons can be made.

The majority of sherd-tempered specimens from the earlier deposits at Forked Lightning (Test D, Cuts 4 to 7—see Graph VII) are distinctly related to Blue-gray in clay base and finish. This conclusion is further borne out by absence of this particular kind of sherd-tempered pottery in the material from Galisteo Basin sites, while 12% was found in the Tesuque site. This pottery may represent a transitional stage between a Chaco-like type and Blue-gray. Small sites containing pottery similar in surface characteristics to Chaco Pueblo II are known in the area. The pottery has a light gray or whitish, fine, sherd-tempered paste and is decorated with mineral paint. The ware is thin and well smoothed and the black or brown mineral paint is readily distinguished from an organic paint by "body," or relief and the fact that it has a uniformly dull or matte surface in contrast to the sheen of the organic paint when it is applied on a polished surface.[1] Pottery from two sites on the Pajarito Plateau, south rim of the Rito de los Frijoles, suggests a transition from the sherd-tempered to the tuff-tempered or untempered pastes of Blue-gray. Sherds from the first site, 1½ miles east by trail from Frijolito, were entirely of the former type; those from the second site, ½ mile east by trail from Frijolito, included some of the Chaco-like type, but were mostly decorated with organic paint and included examples of sherd-tempered and untempered pastes, though the majority were tuff-tempered. It would seem that organic paint was substituted for mineral paint before it was found that the labor of granding sherds for temper was unnecessary, and there may have been several successive changes in the kind of tempering material selected, or possibly there was a short experimental period, or adoption of distinct classes of temper in different parts of the region. These are problems to be worked out in the detailed study of this area. The important fact at present is the occurrence at Forked Lightning of the sherd-tempered subtype of Blue-gray, which should materially assist in correlating the occupation of the site with the main area. The presence

[1] The paint of several of the Chaco-like sherds from Forked Lightning was tested microchemically. It gave a strong reaction for iron but none for manganese.

in Test D of the above-mentioned sherds of the Chaco-like type, having sherd temper and mineral pigment, is likewise significant (see Graph VII). There also occurred occasional sherds of Chupadero Black-on-white,[1] a type which represents the survival in the general Rio Grande area of the use of mineral paint and is also related to the Chaco-like type by its sherd-tempered paste. Chupadero sherds occurred in Cuts 5, 4, 2, and 1 of Test D; and Cuts 6 and 4 of Test VI, their ratio to total Black-on-white sherds varying from 0.5 to 2.0%. The type was not found in deposits later than Cut 4 of Test VI.

Pecos Crackle is the principal Black-on-white type found in the sites of the Galisteo Basin and this area can be regarded as its immediate place of origin or source of influence.[2] The same problems suggested in the discussion of Blue-gray must be considered in the final analysis of Crackle. Were Pecos potters slavishly following the same standards as their neighbors to the west or were they obtaining from them by trade a large amount of pottery? Sherd temper generally offers little encouragement to analysis for the purpose of locating the source of material. But some Crackle sherds are a notable exception. The sherd temper in these specimens of Crackle is clearly from cooking-pots, for the sherd fragments are not only blackened, but contain mineral inclusions far coarser than those in any contemporary Black-on-white ware (fig. 305, *c*). A close examination of these reveals the kind of culinary sherds which the potters ground for temper. The mineral inclusions in these sherd fragments are not sand, as would be expected, but porphyritic rock of intermediate composition. Culinary sherds from several sites in the Crackle area were examined; rock temper was found in sherds from a site on Arroyo Cuervo (L. A. 359) (volcanic breccia from the vicinity); and from Pueblo Blanco (L. A. 40) (porphyry from Cerro Pelon). All culinary sherds of Cuts 10 and 9, from Nelson's Refuse B at San Cristobal, were rock-tempered and also a third of those in Cut 8, which just precedes the abrupt decline of Black-on-white in this test. The remainder of the culinary sherds in this test and in the later strata of Glaze times were sand-tempered. The use of rock temper for culinary pottery, therefore, seems to have been an established custom in this area at the height of the Black-on-white period. The culinary ware of Pecos on the other hand was not rock-tempered, the rare sherds (a fraction of one per cent of total culinary in all except one cut) being evidently intrusive from the Galisteo. Pecos potters would hardly have gone twenty miles or more to the villages of the Galisteo for sherds to grind for tempering material when they were abundant on their own refuse heaps, and therefore Crackle vessels with rock-tempered culinary sherd temper were undoubtedly made in the Galisteo sites

[1] Mera, 1931.

[2] The original sources of influence which stimulated the development of these types is outside the scope of the present paper. However, Crackle has technological features in common with northern San Juan Black-on-white which bear out the resemblance stressed by Mr. Amsden (Vol. I, p. 71). But though the Galisteo development may well represent a San Juan influence, it is improbable that the contact was by way of the Chama Valley as suggested by Mr. Amsden, for Crackle type is absent or exceedingly rare in sites of the Chama and the Rio Grande north of Santa Fe. Mr. Amsden's hypothesis that a Blue-gray hard paste ware was introduced from the northern San Juan and merged into the soft-paste ware (Vol. I, p. 70) is difficult to understand in view of the fact that the hard-paste type does not become abundant until comparatively late in Black-on-white times.

and reached Pecos by trade. While it is proven that some of the Pecos Crackle pottery is intrusive, the volume of trade cannot be calculated without petrographic analysis of stratigraphic material, for the inclusions in fragments of sherd temper can be identified only in thin section. Examination with the binocular microscope reveals the proportion of Crackle containing culinary sherd temper (approximately 50% in the period when the type was at its height) and all of these would have to be sectioned. The thought naturally occurs that the whitish paste, hard slip specimens may all be intrusive, especially as this paste has the properties characteristic of the clays of the Galisteo formations, and that the soft slip, more friable paste specimens are the results of the efforts of Pecos potters. The former type is more numerous in the lowest level at Pecos. A high percentage of intrusive pottery might be expected in this level since at the time the energies of the people were centered in the establishment of the new settlement. Stratigraphic material from the Galisteo sites will be important in the final solution of this problem.

Biscuitoid, a tuff-tempered type, appears to be a specialization of Blue-gray and may also be intrusive at Pecos. The reasons advanced for the theory of importation of tuff-tempered Blue-gray also apply in this case. The possible relation of Biscuitoid to Biscuit ware is considered in the dicsussion of the latter type (see p. 497).

Rowe Black-on-white stands out from all other types of the period as the one distinct development of the Pecos region. Both material and distribution support this conclusion.[1] The custom of slipping the exteriors of bowls may have been suggested by Crackle which was dominant when Rowe was first made; the clay is of the same class as that used in Blue-gray and the addition of siltstone temper may have been an innovation of the Pecos potters, at least it later became an established custom. The derivation of the flare rim of bowls is not clear, for flare rims are found, although very rarely, in all three of the Black-on-white types of the area. Perhaps this characteristic of form, or rather the frequent resort to it, also originated with the Pecos potters.

Viewed in its chronological sequence the Black-on-white ware shows in early Forked Lightning times the complete dominance of the Rio Grande area with the contemporaneous occurrence of three varieties of the same type, one of which may be transitional from an earlier type. Then by middle Forked Lightning times the influence of the Galisteo became as strong as that of the Rio Grande and almost completely superseded it during the early occupation of Pecos. Finally as the Galisteo influence in turn declined, modified types from the Rio Grande came in and the Pecos potters themselves produced a distinct, if short-lived, type of their own. It is beyond question that a good deal of pottery was obtained in trade from both areas throughout the Black-on-white period and at the same time both of the principal types, Blue-gray and Crackle, were probably copied at Pecos with local material. It is also possible that clans from the Galisteo and the Rio Grande joined Pecos at

[1] The Laboratory of Anthropology's archaeological survey material from Black-on-white sites of the Upper Rio Grande was examined and the type found in Dick's Ruin (L. A. 276) one mile below Tex Austin's Ranch on the west side of the Pecos River and on a site near La Cueva (L. A. 67), but was absent from the ruins in the Galisteo Basin and the Santa Fe region.

various times and continued to practice their particular arts as best they could with new materials.

BISCUIT WARE

BISCUIT A

Megascopic observations. Biscuit A paste appears homogeneous and open in texture; few inclusions are visible to the unaided eye. The fracture is typically straight and at right angles to the vessel surface. White flecks (tuff) and occasionally transparent grains (quartz or sanadine) and plates of mica can be detected with a 10-power hand lens. The presence of tuff in Biscuit paste has long been suspected because of the physical properties of the ware and its geographic distribution. The fact that tuff has not hitherto been identified, therefore, illustrates the inadequacy of megascopic observations.

Temper. All Biscuit A sherds examined were tuff-tempered. No distinct or consistent variations in texture of tuff or in mineral inclusions were discovered. In some sherds flowage flakes and fine pumiceous particles are prominent, while in others stubby rods and forked forms from bubble rims are most conspicuous, but often these various textures are associated in the same specimen and they appear to grade into one another. The refractive index of the tuff is 1.505.

Mineral grains are scarce compared with the tuff, but quartz and feldspars are always present. The feldspars, which include sanadine and acid plagioclase, are clear and unaltered. Occasional rims of glass surrounding these mineral grains prove that they are phenocrysts from the tuff. Other minerals occur sparsely, the most common being biotite, hornblende (brown or blue-green), calcite, augite and zircon, but no one of these was found in every section. In less than half of the sections there were small flakes of muscovite, or a pale green mica, and minute grains of magnetite, apatite, enstatite, epidote, zoisite and garnet. Some sections contained as few as two minerals, in addition to feldspar and quartz, generally hornblende or biotite, and calcite, while in others eight or nine minerals were found. But no consistent variations in mineralogical composition were discovered. Stray fragments of cryptocrystalline rock and basalt are sometimes present.

Texture. The majority of tuff flakes are between 0.08 and 0.16 mm. in diameter and the largest particles in the coarsest-textured sherds are 0.64 mm.; in the finest-textured sherds they are 0.16 mm., and the largest in all sections examined averaged 0.30 mm. The majority of quartz and feldspar grains have the same range in size as the tuff flakes. Most accessory minerals are between 0.03 and 0.08 mm. in diameter.

The *volume* of tuff temper cannot be determined by micrometric methods, or chemical separation. Judging from the appearance of the paste in thin section, Biscuit ware contains considerably more tuff than the majority of tuff-tempered Black-on-white specimens and there is less variation in the ratio of temper to clay.

Clay is tan or light brown in transmitted light, under crossed nicols moderately birefringent, occasionally strongly birefringent or isotropic. The pastes with brightest birefringence lack the definite orientation of clay particles noted in Biscuitoid.

The refractive index is relatively uniform and low—1.524 to 1.532 for the majority of sherds, 1.505 to 1.495 for the whitish paste.

Physical properties. *Color* includes grays—15''''i to b (Mouse Grays), and grayed tints of orange-yellow—17'''b (Avellaneous), 17'''f (Tilleul-Buff), 17''''f (Pale Drab-Gray) and occasionally tints paler than 17'''f. The tints of 17''' and 17'''' are found in from 20 to 30% of the sherds; the remaining sherds are various intensities of 15''''. Core-margin variations appear in 10 to 25% of the sherds; occasionally the outer zone of the vessel wall is darker than the inner. Cores, either wide or narrow, are 15'''' to 15''''i and margins, 17''''f, 17'''b and 17'''f, rarely paler. In many pastes having these color variations, there are no distinct zones but rather a very gradual blending of colors. Oxidized at 850° C. for 30 minutes the color becomes 11'b (Apricot Buff), 13'b (Ochraceous-Salmon), or 13'' (Orange-Cinnamon). Refired to 1200° C. the color is either 17'''' (Drab), 21''''b to d (Light Grayish Olive to Smoke Gray), or 7'm (Liver Brown). *Hardness.* Slightly over 3, very rarely 4. Unslipped exterior surfaces have the same hardness as the paste. Refired to 1200° C. the paste becomes 7+ in hardness. *Modulus of Rupture.* Average—119 kg. per sq. cm.; range—92 to 155. *Strength of Vessel Walls.* Average—45 kg. per 2.5 cm.; range—33 to 68. *Apparent Porosity.* Average—36.6%; range—31.8 to 40.4%. Refired to 1200° C.: Average—6.5%; decrease—82.2%.

Slip. The majority of sherds are slipped on the interior but a few are unslipped, though indistinguishable in surface texture. *Color* is typically 17''''f (Pale Drab-Gray) or paler and slightly more grayed than 17'''f (Tilleul-Buff), occasionally 17'''d (Vinaceous-Buff). Refired to 1200° C.—21'''b or d (Deep Olive-Buff or Olive-Buff). *Hardness.* 3. Refired to 1200° C. it is increased to 7+, and the surface becomes finely vesicular. *Thickness.* 0.02 to 0.03 mm. *Finish and Wear.* Slips are very well smoothed with horizontal strokes. No roughness or grittiness can be felt but surfaces are not lustrous. Crazing or peeling is exceptionally rare and where subject to abrasion paste as well as slip is worn. *Optical Properties* are the same as those of the paste.

Paint is organic. *Color.* Dusky Neutral Gray, *m*, or more nearly black, occasionally Dark Neutral Gray, *k*, or Deep Neutral Gray, *i*. Surfaces have the same texture as the slip but appear somewhat more lustrous. Thin sections show that the paint penetrated one-third to one-half the depth of the slip. There is no evidence of the paint having caused the slip to craze.

Firing. Calcite is present in 66% of the sherds thin-sectioned, indicating that the temperature range was low. The paste of 20% of the specimens examined has bright birefringence which is unaffected by refiring to 850° but destroyed at 900° C.

The predominating gray pastes when compared with the relatively clear orange-yellows obtained upon refiring show that firing treatment was seldom such as to fully oxidize the paste.

BISCUIT B

Megascopic observations. The paste of Biscuit B is indistinguishable in texture from that of Biscuit A, and the principal difference between the two types is

in color range. The grayed tones of orange yellow-orange and yellow-orange are much more frequent and clearer in Biscuit B than in Biscuit A.

Temper is entirely tuff having the same textures and intergradations of texture as found in Biscuit A. Mineral inclusions are always sparse and sherds vary considerably in the number and variety of accessory minerals. The common accessories are the same as those in Biscuit A, but apatite, epidote and enstatite were not found, while zoisite and titanite occurred in several sections. Pastes containing numerous flakes of biotite are more common than in Biscuit A. Biotite and muscovite are rarely found in the same section. Dark-brown earthy particles, rare in Biscuit A, occur in nearly one-third of a group of twenty-one Biscuit B sherds found in general digging. The particles vary from 0.04 to 0.08 mm. in diameter and appear to have been introduced with the tuff as they sometimes fill the gas bubbles.

Texture. The average size of tuff particles, 0.08 to 0.16 mm. in diameter, is the same as in Biscuit A, but the coarsest fragments, 0.32 mm. in diameter, are half the size of the largest particles in Biscuit A. Mineral grains, average—0.09 mm., maximum—0.48mm. in diameter, are slightly finer than in Biscuit A.

Clay is tan or light brown in transmitted light, generally brightly birefringent, but clay particles are seldom noticeably oriented. Refractive index is variable, 1.523 or 1.536 in the majority of pastes, occasionally, 1.516; the whitish paste is 1.505.

Physical properties. *Color.* The clearest colors are 13″b (Vinaceous-Cinnamon) and 15″b (Pinkish Cinnamon), which grade into 17‴b (Avellaneous) and 17‴d (Vinaceous-Buff) respectively. Approximately half of a group of 30 sherds obtained from general digging and 54% of the sherds from Cut 7, Test XXI, are of these colors, which are distinctive and much more common in late than in early Biscuit B. Approximately one-fifth of the sherds have core-margin variations, usually 15⁗ cores and 17⁗f (Pale Drab-Gray) margins. Sherds entirely 15⁗ to 15⁗d are not uncommon in early Biscuit B. The whitish paste is rare. Oxidized at 850° C. for 30 minutes the paste becomes 11′b (Apricot Buff), 13′b (Ochraceous-Salmon), or 13″ (Orange-Cinnamon); refired to 1200° C. the color becomes either 17⁗ (Drab), 21⁗b to d (Light Grayish Olive to Smoke Gray), or 7′m (Liver Brown). *Hardness.* No paste harder than 4 or softer than 3 was found, but the majority are nearer 3 than 4. Refired to 1200° C.—7+. *Modulus of Rupture.* Average—106 kg. per sq. cm.; range—82 to 126. *Strength of Vessel Walls.* Average—39 kg. per 2.5 cm.; range—18 to 57. *Apparent Porosity.* Average—38.0%; range—31.9 to 41.9%. Refired to 1200° C.: Average—7.5%; decrease—80.3%. The original porosity of a few sherds of known chronological position was also tested with the following results: 6 early sherds—37.4%; 4 late sherds—36.0%; 3 Sankawi Black-on-cream sherds—34.2%. These variations seem to indicate a decrease in porosity towards the end of the period, but more sherds should be tested to establish a difference.

Slip. The majority of sherds are slipped on both interior and exterior but a few are unslipped. In thin section the marginal part of these appears darker and more dense than the remainder of the paste but there is no sharp line of demarkation and the tuff particles are equally abundant at the surface and in the paste. These unslipped specimens can sometimes be recognized megascopically by the scintillation

from innumerable minute points which superficially suggest very fine abundant mica flakes but which upon microscopic examination are found to be glassy plates of tuff. Three sherds of this kind were found in a representative group of 33 Biscuit B sherds from Pecos. Slipped and unslipped sherds are indistinguishable in surface texture. *Slip color.* 21″″f (Pale Smoke Gray), 15″″d to f (Pale to Pallid Mouse Gray) and 17″d to f (Vinaceous-Buff to Tilleul-Buff). As in the paste, the less modified colors are more common among sherds from late than from early levels. Oxidized at 850° C. for 30 minutes. 17″i (Tilleul-Buff), 15″d (Light Pinkish Cinnamon). Refired to 1200° C. 21″d to f, (Olive-Buff to Pale Olive-Buff). *Hardness.* 3 to 4.5. Refired to 1200° C. 7+. Becomes finely vesicular. *Thickness.* 0.05 to 0.14 mm. *Finish and wear.* Uniformly very smooth but without luster. Approximately one-quarter of the slips are finely crazed. Occasionally worn, particularly on the interior. *Optical Properties.* The same as those of the paste.

Paint is organic. *Color.* Typically Dusky Neutral Gray, rarely lighter; on the white paste 15″″i (Deep Mouse Gray).

Firing. Calcite was found in 7 of the 17 sherds thin sectioned and 12 of these had distinctly birefringent pastes.

Paste colors indicate that firing treatment became more fully oxidizing as the period advanced.

INTERPRETATION OF TECHNOLOGICAL DATA

Biscuit is technically, as well as stylistically, one of the most distinctive of Upper Rio Grande wares. It is highly standardized in workmanship, form, and design and is definitely restricted in geographic distribution. It appears from surface evidence to have been the only painted ware of its period in certain large sites in the Chama drainage and on the northern part of the Pajarito Plateau, but at Pecos it was always a minor ware.[1] Biscuit belongs to a totally different ceramic category from Glaze, the principal contemporaneous decorated ware, for it is unrelated in style and made from a distinct class of materials. Nevertheless, the Biscuit ware found at Pecos has hitherto been considered the work of local potters. The fact that its origin has not been questioned is perhaps explained by the basis upon which intrusive pottery is generally recognized. The chief criteria to date of trade ware have been percentage of occurrence and distance from center of distribution. When, for example, sherds of a Little Colorado type are found at Pecos in numbers amounting to a fraction of one per cent, there is no question regarding their foreign derivation. Knowing that pottery was obtained from such remote regions, we may reasonably suppose that there was also exchange between neighboring pueblos, yet the distribution and the amount of such pottery may give no evidence of its origin. The technological investigation, however, has shown that materials may furnish definite clues to the provenience of pottery even within small areas, for clays, tempers and pigments can be identified with a high degree of accuracy by petrographic

[1] Dr. Kidder (Vol. I, p. 157) has shown that, with the exception of the strata in which the wares first appear, the ratio of 15-20% Biscuit to 80-85% Glaze is relatively constant in all refuse examined.

and chemical methods and their geographic occurrence determined within narrow limits by geological field work. But the discovery that one or more of the substances used in making a vessel came from a distant source does not constitute proof that the vessel was intrusive, for raw material may also have been imported. The technological evidence must, therefore, be interpreted in the light of our entire knowledge of cultural development, contacts and distributions. The problem would be solved directly by discovering, in the course of excavations, caches of imported raw materials, but these unfortunately are rarely found. However, the status of ceramic advancement, the number of foreign materials identified in a single type, the association of local and imported materials, the standardization of a type, and the degree of similarity in composition and workmanship between the questionable type and contemporaneous wares are all significant.

Various kinds of temper, which do not occur in the immediate vicinity of Pecos, have been found in the Black-on-white types of this site and serve as evidence of trade. The temper itself is sometimes of such a nature as to leave no doubt that the finished vessel rather than the raw material was imported, for the same class of material was abundant at Pecos and could be distinguished from that in the pottery only by the petrographer; such for example is the potsherd temper of Galisteo origin in Crackle Black-on-white. Tuff temper in a variety of Blue-gray has tentatively been regarded as evidence of barter for vessels, because a variety identical in outward appearance was made from local material and because there is no indication of the high ceramic standard which would be expected were materials sought at great distances. Biscuit ware was always tuff-tempered and much of it contains a highly vesicular pumiceous tuff which must have come from the main formation rather than from the finely sorted secondary deposits in the Santa Fe marls of the valley, which were considerably nearer Pecos and known to potters of the Black-on-white period. Biscuit was also made from an unusual kind of clay having distinct optical properties and firing behavior which facilitate comparison and show conclusively that it does not occur in the sedimentary formations of the Pecos region. Accordingly, neither slip, body clay, or temper could have been obtained within a convenient distance. The probability that Pecos potters would have gone forty to fifty miles to obtain pottery clay with which to make technically inferior bowls is very slight, and the distinctive style of the ware, together with its limited distribution and high concentration in the area where its type of clay and temper are found, throw the balance of evidence strongly in favor of the trade explanation.

Biscuit is unique among the pottery types of the Southwest. The physical properties of the ware are quite as distinctive and unusual as its highly standardized vessel form and style of design. The paste is extremely porous, seems light in weight, and has a distinct color range. Sherds fired to 1200° C. are completely vitrified and many change to a rare drab color. One of the principal and most interesting technological problems in connection with Biscuit is to explain these peculiar properties. What makes the paste so light and porous? Is it the kind of tempering material, the quality of the clay, the method of firing, or a combination of all three? The geographic distribution of Biscuit approximately coincides with the area in which rhyolite tuff occurs and the possibility that volcanic ash was used for temper was

recognized a number of years ago.[1] Petrographic analysis has proved this surmise correct, for the paste is invariably tuff-tempered, usually more heavily than Black-on-white or Modern types having the same kind of tempering material. Tuff, which is often vesicular in texture, would naturally be expected to increase the porosity of the paste. But experiments have shown that when tuff temper is substituted for sand temper, porosity is not increased sufficiently to account for the peculiarities of Biscuit ware.[2] A comparison of tuff-tempered wares also indicates that tuff is not the chief cause of high porosity, for some specimens of Black-on-white ware, which are as heavily tempered as Biscuit with equally coarse tuff, are not excessively porous.

Biscuit differs from all other wares found at Pecos in the optical properties and thermal behavior of the clay base. Low refractive index and marked birefringence, which is lost upon reheating to 900° C., identify Biscuit clay with the montmorillonite group of clay minerals rather than the kaolinite. The working qualities and thermal behavior of the original Biscuit clay would be most directly determined by a thorough examination of the clays of the Biscuit area. As this is beyond the scope of the present study, only a cursory survey was made, which, however, may suggest problems for future investigation. In the course of this reconnaissance a peculiar class of clays, possessing unusual physical properties, was found in the Biscuit area. They are formed from the decomposition of volcanic ash and are, therefore, classed as bentonites.[3] Evidence of their origin is preserved in the ash texture which is discernable in thin sections. The common clay mineral of the bentonites is montmorillonite, which has lower refractive indices and higher birefringence than kaolinite and related minerals. The bentonites are highly adsorptive and water dropped on a lump is quickly soaked up, the lump swelling to several times its original size; consequently, with the large amount of water lost in drying, shrinkage is excessive and cracking unavoidable without considerable tempering material. Bentonites are usually formed from the less acid glasses, those which do not contain a large excess of silica, and in the Biscuit area occur on the northern side of the Jemez crater where the andesitic tuffs from the first eruption are found. Material has been examined from the valley of the Rio Oso, Vallecitos Creek, and Santa Cruz Valley. These bentonites are seemingly unsuitable for pottery making because of insufficient cohesiveness and high shrinkage. It is probably impossible to prove conclusively that bentonite was used in pottery making, because the delicate ash texture, resulting from the replacement of odd-shaped tuff flakes by clay, would be destroyed when the paste was kneaded, but comparison of optical properties of clays fired

[1] Nelson (1916, p. 169), in describing Biscuit paste, states: "The composition suggests nothing so much as ground-up pumice stone or volcanic tufa, a substance which is so very abundant in the Pajarito region where Biscuit ware is most plentiful."

[2] It was found by experiment that the apparent porosity of a paste fired to 850° C. is no greater when tempered with fine-textured tuff from secondary deposits than when tempered with sand or basalt of the same grain size. A large amount of highly vesicular tuff may affect the weight of the paste more than its apparent porosity, for the air bubbles in the glassy tuff are largely sealed and their volume is, therefore, not recorded with the porosity determination.

[3] Ross and Kerr, 1931, pp. 55-65. Ross and Shannon, 1926, p. 77-96.

within the range of temperatures obtained by the Pueblos, together with general thermal behavior, gives promise of showing at least the class of clays used. Certain sedimentary clays found in the Biscuit area though more easily worked than the true bentonites also have exceptionally high shrinkage and low fusion point. The presence of montmorillonite, which is not limited in its occurrence to the bentonites, probably gives these clays their characteristic properties. The use of this kind of clay would seem to explain many of the peculiarities of Biscuit paste. Optical properties and thermal behavior are in agreement, and the large amount of temper which is typical of Biscuit was undoubtedly used because the clay had high shrinkage.[1] Even the thickness of the ware suggests a clay poor in working quality, for heavy walls become necessary when clays with little cohesiveness are used. Why should these potters have selected such a clay? Was it the only kind available within convenient distance of their villages, or did it possess some advantage which counterbalanced its poor working qualities? Although careful search will be necessary to determine all the types of clay found in this area, the paste of culinary ware contemporaneous with Biscuit and of the Black-on-white types which preceded it indicates that other clays were available, though how conveniently they were located with respect to Biscuit sites has not yet been ascertained. But the change from Black-on-white to Biscuit suggests a deliberate choice of bentonite-like clay. This clay also had one very distinct advantage which may at least partially explain its use by Biscuit potters. When painted with a vegetable pigment a strong black could be produced; in fact clays of this class are the only ones so far found in the Upper Rio Grande area with which it is at all practicable to use an organic pigment (see p. 417). The fact that Biscuit paint is exceptionally and very uniformly dark and decidedly superior to that of any Black-on-white type of the area, is another

[1] Although thin sections clearly show that Biscuit was heavily tempered, a satisfactory method for the exact measurement of the volume of temper has not been found. Since the tuff particles are not generally equidimensional, the Rosiwal method of measuring linear intercepts is not strictly applicable; however, if flakes were not forced into parallel position, the micrometric method might seem to offer a means of at least estimating the volume of temper. Accordingly, the Rosiwal method was checked with specially prepared test pieces containing a known volume of tuff. It was found necessary in making the counts to use high magnification (360x), for the boundaries of flakes and many small particles are discerned with difficulty. Even when the greatest care was exercised, estimates were low; the method is, therefore, deemed unreliable. But an idea of the relative amount of tuff is gained by an observation of the area occupied by tuff flakes in a specimen of known composition with that in the unknown. A prepared section containing 25% tuff appeared sparsely tempered when compared with all sections of Biscuit ware. The possibility of estimating volume of temper by a chemical separation of clay and tuff was also tested, since Biscuit paste, having been fired at low temperatures, is attacked by acid. The procedure adopted is similar to that used in the rational analysis of clay. There remained from the treatment of a typical Biscuit sherd a residue which amounted to 58% by weight of the original sample. This insoluble part proved upon microscopic examination to be composed principally of tuff but there was also some exceedingly fine birefringent material derived either from the clay or the mineral matter associated with the tuff. This figure, therefore, gives only an approximation of the proportion of temper. The weight of the tuff may also differ considerably from its original volume since its bulk is increased by air bubbles, and this factor is difficult to check because tuff textures vary within wide limits. Insolubility of the clay of well fired pastes, aside from the variable proportion of insoluble matter in the clay makes chemical separation generally impracticable as a means of determining percentage of temper.

indication of the quality of the clay, and must undoubtedly have been recognized by the potters.

The third possible cause contributing to the softness and porosity of Biscuit paste is firing treatment. The presence of calcite in many of the sherds gives evidence of low firing. Birefringence of the clay also is an indication of firing temperature. This property is found only in clays having a crystalline habit and is lost when the clay is heated high enough to destroy the crystal form. Since the original firing temperature did not reach this point, refiring to the temperature at which this property is lost sets an upper limit above which the pottery was not fired. It was determined by refiring sherds to 800°, 850° and 900° C. that the change takes place between 850° and 900° C., for all paste became isotropic at 900° C. Although firing temperatures were consistently low, this alone would not account for the properties of Biscuit paste, because some wares having the average porosity of dense pastes were originally fired no higher than Biscuit ware; and likewise ordinary pastes tempered with tuff and fired as low as Biscuit do not develop Biscuit properties. The kind of clays occurring in the tuff area is therefore the primary factor in producing this unusual paste, and their thorough investigation and comparison with Biscuit paste is an inviting problem.

Sherds of Biscuit ware show little variation in the composition of the paste but color differences developed by higher firing (1200° C.) indicate that clay from more than one deposit was used. Some sherds turn a chocolate brown while others change to various tones of drab. These two kinds of clay are found in both Biscuits A and B from Pecos. Sherds from three sites in the Biscuit area, Sankawi (L. A. 211), and Tshirege (L. A. 170) on the Pajarito Plateau and Poshu (L. A. 274) in the Chama Valley, were also refired to determine whether there is a well defined geographic distribution of the types. In the two Pajarito sites approximately half the refired Biscuit A sherds were of the drab paste, which, however, decreased to one-tenth in the Biscuit B specimens; whereas in the Chama site two-thirds of the Biscuit A sherds were made from the drab paste and the decrease in proportion in Biscuit B was not great (16%). Both pastes seem, therefore, to have been generally available to the potters of these sites, but use of the drab persisted longer in the Chama region. The brown paste cannot be distinguished from the drab in the original sherd as there is no difference in texture and each has the same color range at the low temperatures of primitive firing. Optical properties likewise show no significant difference, and this fact together with similarity in porosity, strength, and vitrification point indicates that they belong to the same class of clays, differing principally in iron content or the form in which the iron is combined.

The slip clays all refire to drab and are the same as some of the drab pastes. It is surprising to find that the slips on the brown paste variety, which cannot be distinguished in color from the paste in the original sherds, are brought out in sharp contrast upon refiring. The drab clay must therefore have had some superior quality for slipping purposes, possibly fineness or smoothness, which was recognized by the potters.

Considering the extreme porosity of Biscuit paste, its strength is not as low as might be expected. The average strength per square centimeter of paste is less than

that of Glaze and most Upper Rio Grande Black-on-white pastes, but the greater thickness of Biscuit vessel walls more than compensates for the lower modulus of rupture, so that Biscuit is actually the strongest ware found at Pecos. This fact is perhaps partially explained by lack of brittleness, absence of coarse inclusions, and the flaky form of the temper. Dr. Kidder has recorded the fact that Biscuit bowls were sometimes used until their bases were worn to extreme thinness and yet specimens found with burials are often broken into small fragments.[1] Since pottery buried in the earth is usually damp, Dr. Kidder's observation raises the question whether pastes are weaker when wet than when dry. The strength of both Biscuit and Glaze sherds when wet and dry was, therefore, compared by cutting two test pieces from each sherd, one of which was saturated with water before breaking. Saturation was found to have little effect on Glaze sherds but Biscuit sherds lost an average of 20% of their original strength, which loss brought them well below the strength of Glaze. The excavator recognizes the weakness of some types of pottery when damp, for he considers it safer to expose a bowl to the air long enough to dry before removing it from the ground. The fact that all pastes do not show the same relative decrease in strength when wet is probably explained by differences in the degree to which the clay was altered in firing. Although Biscuit paste is completely fused at 1200° C., vitrification takes place suddenly at temperatures above the Pueblo's maximum; primitive firing treatment changed Biscuit clay less than it did Glaze clay.

Although Biscuit seems softer than other wares from this area, scratch tests do not show marked differences between it and some Black-on-white types. The smoothness of texture, fineness of temper and sparseness of quartz grains influence judgment regarding softness. However, Black-on-white types (Blue-gray and Biscuitoid) are nearer 4 in hardness, and Biscuit is nearer 3.

Significant chronological changes in workmanship and style have been revealed by Dr. Kidder's very thorough analysis of Biscuit design and rim form.[2] Differences in technological features are less marked. The same pastes were used for both Biscuit A and Biscuit B, but there is a progressive change in color of paste. The majority of Biscuit A sherds are shades of 15''''' (Mouse Gray), while Biscuit B sherds not only include more of the orange-yellow tints but are also distinctly brighter and clearer than those found in Biscuit A. This difference can be explained by firing atmosphere alone. A poor draft and consequent reducing gases will produce grays and grayed colors. The Black-on-white types of the Upper Rio Grande were seldom oxidized in the firing; had they been, the organic paint would have burned out completely, for the slip clays did not have the properties necessary to protect the paint. Biscuit clays did possess these properties to a marked degree. The method of firing developed in the Black-on-white period may have been followed for a time after the discovery of Biscuit clays; but experience eventually would teach the potters that they could fire with a better draft and so obtain pleasing creams and buffs instead of grays. Although the degree of oxidation indicates that firing methods changed during Biscuit times, there is no clear evidence of simultaneous change in firing temperatures. The percentage of sherds containing calcite is lower in Biscuit B than in

[1] Vol. I, p. 74. [2] Vol. I, pp. 73-130.

Biscuit A, which decrease may mean either that Biscuit B was more often fired to a temperature which decomposes calcite or that it occurred less frequently in Biscuit B paste. While the same classes of clay, the brown and the drab, were used for both types, Biscuit B shows a higher percentage of the brown paste in which calcite is more common. There are minor differences in physical properties, Biscuit A being slightly stronger and less porous than Biscuit B, but these variations may not be due primarily to firing temperature. In addition to the occurrence of calcite, the many examples in both types of birefringent clay which becomes isotropic upon refiring at temperatures between 850° and 900° C. proves that low firing temperatures were used throughout the period.

The relationships of Biscuit to the wares which immediately preceded and followed it are of particular interest because of its unique and unusual physical properties and its standardized and distinctive form and design. What actually constitutes relationship between wares, or rather what is the significance of similarities in pottery types? Biological concepts have unfortunately crept into ceramic studies to the extent that it has become customary to speak of one ware as *ancestral* to another or to call one which has resemblances to several others a *hybrid* or a *sport*. These are perhaps simple and convenient terms to express degrees of similarity and time relationship, but the archaeologist who uses them all too often inadvertently falls into the habit of thinking of the pottery as an entity in itself apart from the potter who produced it. A pottery type of one period may have various characteristics in common with types of other periods. First, they may be made with identical materials, because the same clays, tempers or pigments are used until better ones are found to replace them, or until the source is exhausted. Second, the same method of workmanship, form or style of design may have persisted for a long time because of the conservatism of potters, the tendency to cling to the established ways of doing things, to repeat familiar patterns. If, on the other hand, two wares differ in any of these respects we may consider that potters had changed their materials, methods or concepts of the useful and beautiful for one or more reasons. They may have come in contact with potters following different standards, from whom they borrowed new forms, designs, even materials, either copying outright or adapting and combining with their own traditional practices; or again there may have been gradual changes, growing skill and sense of pride, a general elevation of standards, or a decline may have set in because of carelessness and indifference, other interests or necessities; and, finally, abrupt changes may have been made through the influence of some particularly gifted individual. Outside of the fact that pottery supplies us with a descriptive label for cultures and, when exchanged, a means of establishing contemporaneity, our interest in it is determined by the extent to which it reflects material and social conditions, because it records relative rates of change, the course of development and the way in which one group influenced another. But if a kind of geneological chart is used to represent hypothetical relationships there is danger that arbitrary classification, based all too often on superficial study, will cloud the real issue; the method may become more engrossing than the problem. When the pottery types of an area show apparent resemblances, it is

essential that the points of similarity be specifically determined and their possible significance considered.

The direct development of Biscuit from Wiyo (= Biscuitoid), a Black-on-white type, has been postulated and all stages of the transition are said to be found in certain sites of the Santa Fe area.[1] Comparison of design and form cannot be considered here, but from the studies made by Dr. Kidder and Mr. Amsden it is apparent that Biscuitoid had more features in common with the other Upper Rio Grande Black-on-white types than with Biscuit.[2] Of the various technological features, both organic paint and tuff temper are common to a number of Black-on-white types and Biscuit. It is in the character of the clay particularly that evidences of transition should appear. Biscuitoid paste is slightly more porous than that of Blue-gray or Crackle, and the relative frequency of blackish paint suggests that Biscuitoid slip protected organic matter somewhat better than did the slip clays of other Rio Grande Black-on-white types. In these respects Biscuitoid is intermediate between Black-on-white and Biscuit. Optical properties and thermal behavior, however, show that the clays used for Biscuitoid and Biscuit are not of the same class and there is no evidence that those used for one ware graded gradually into those of the other. From the technological standpoint therefore Biscuit does not result as a gradual development from Biscuitoid, but instead shows clearly the discovery and use of a new kind of clay. These clays may, of course, have been found and tried slightly before Biscuit style was developed. A few Biscuitoid sherds made of Biscuit paste were found at Perage (L. A. 41), but these were exceptional. The area of principal occurrence of Biscuitoid does not coincide with that of Biscuit; the former is most abundant in the sites on the east side of the Rio Grande and in the valley proper and is rare in the villages of the Pajarito Plateau and the Chama, the focus of Biscuit ware.[3]

The painted ware which immediately followed Biscuit, Sankawi Black-on-cream, is represented at Pecos by only a few sherds and consequently a detailed study was not practicable, but sherds from the home range of this type were also examined. They show no important change in tempering material, quality of slip or kind of paint. The paste of Sankawi Black-on-cream and also that of Potsuwi'i Incised is similar in optical properties and thermal behavior to Biscuit brown paste, but the drab paste, less common in Biscuit B than in Biscuit A, was not found in either of the later types. The comparatively thin walls of the wares which followed Biscuit may possibly be explained by the use of a more plastic clay. But a thorough and detailed analysis will be necessary to determine whether the pastes of Sankawi Black-on-cream and Potsuwi'i Incised are identical and different from Biscuit, as has been postulated.[4]

Thus we see that the tuff-tempered bentonite-like clay from which Biscuit was made is undoubtedly an important factor in explaining its limited geographic distribution, which approximately coincides with the area of Tertiary eruptives on the east side of the Jemez Plateau. Biscuit, because of its soft porous paste and thick walls, is technically inferior to Glaze ware; nevertheless, some Biscuit sherds occur

[1] Mera, 1934, pp. 9, 17. [2] Vol. I. [3] Mera, 1934, pp. 13-14. [4] Mera, 1932, p. 8.

in Rio Grande Glaze sites south of the Biscuit area, indicating that it was an object of trade. Though never a major ware at Pecos, Biscuit is found in sufficient quantity to suggest that it was made locally. The theory that it was entirely intrusive has been advanced on the basis of technological evidence which shows that neither clay nor temper are to be found within forty or fifty miles of Pecos. This interpretation is consistent with the fact that decorative motives and systems of design of Biscuit and Glaze are quite distinct, a fact difficult to explain if both were made by the same people. The origin of Biscuit and Glaze in sites where they appear to be equally abundant is still to be determined, and detailed studies will also disclose the extent of the Biscuit area more accurately than is possible from surface observation. A thorough investigation of the clays of the Biscuit area should reveal sources of supply, minor local variations, and the exact technological relation of such wares as Biscuitoid and Sankawi Black-on-cream. Although only inferior ware could be made from bentonite-like clay, it has the one distinct advantage of holding and protecting an organic paint as no ordinary clay will, and the discovery of this fact by Biscuit potters constitutes a contribution to ceramic art which has influenced even present-day Pueblos.

GLAZE WARE

GLAZE I RED

Megascopic observations. The color and texture of paste are variable but the majority of sherds have a gray core with red-brown margins. The margins are lacking in a few sherds and approximately one-quarter are completely oxidized. The fracture though often straight is rough and earthen. The tempering material can be identified with the aid of a 10-power hand lens in approximately half of the sherds. Most characteristic are opaque white inclusions, porcelaneous in appearance, and a scattering of minute shiny black fragments. The large inclusions can frequently be recognized as crystal aggregates rather than single crystals. Transparent grains are rarely seen. Some sherds contain light brown or gray fragments, often having a vitreous luster, while dull black or dark reddish fractures can be distinguished in others. Rarely the coarser examples of this latter type are seen to be vesicular in texture.

Temper. The majority of sherds are tempered with igneous rock. Several distinct classes of rock are represented but usually each sherd is limited to rock of a single type. The most common is a fine grained intrusive of intermediate composition which may be classed as a diorite (fig. 307, *a*). Porphyries and basalt are also found. The diorite has a fine monzonitic texture (grains average 0.16 to 0.40 mm. in diameter) and is composed of crystals of acid plagioclase, a pale green augite and patches of magnetite. The plagioclase, andesine, exhibits albite twinning and is frequently kaolinized particularly near the center of crystals. Zoning is not uncommon. The augite, which though sparse occurs in larger crystals than the feldspar, is very pale green, has distinct crystal boundaries, shows no alteration but contains conspicuous inclusions of magnetite. Large grains of magnetite are also common in the rock.

Patches of opaque brown material, a product of alteration, are often associated with it. Rarely subangular grains of quartz occur in the paste but they are not found in the rock fractures.

The porphyries differ in texture and mineral composition. The ground-mass is either very finely crystalline or microcryptocrystalline (fig. 307, *b*). The feldspar of the phenocrysts is an acid plagioclase, either oligoclose or andesine and is frequently zoned. Calcite has sometimes formed as an alteration product. Ferromagnesian minerals are represented by either a pale green augite alone or by augite and brown hornblende in nearly equal proportions. The augite is fresh and unaltered but the hornblende is at times entirely replaced by granular opaque material, largely magnetite. One specimen was found in which there was no ferromagnesian mineral and another in which brown, strongly pleochroic biotite was the only ferromagnesian mineral. Biotite was not noted in the rocks containing augite or hornblende nor were accessory minerals distinguished. Quartz is very rare and was found only as free grains in the paste and not in the rock fractures.

Several types of basalt occur. A crystalline type is composed of fine laths of plagioclase closely intergrown with small grains of nearly colorless augite, and a scattering of grains of altered olivine. Some pastes, which appear nonhomogeneous, contain fractures of basalt having a black glassy vesicular groundmass with a few small laths of plagioclase and fragments having a light glassy groundmass closely speckled with fine black opaque grains and containing scattered plagioclase crystals.

A few specimens of Glaze I Red are sherd tempered or contain sherd fragments. The mineral inclusions in these pastes are generally distinctive, consisting either of basalt or fractures of a light brown glassy rock with small needle-like crystallites. The rock fractures in some cases exceed the sherd in number but often occur in both the paste and the sherd tempering fragments and are clearly derived from the latter.

Texture. Average grain size—0.19 mm. in diameter; range in average for sherds—0.12 to 0.27 mm. Maximum grain size: average—0.93 mm.; extremes—0.48 and 1.28 mm. Average grading: very fine—32.0%; fine—50.4%; medium—13.6%; coarse—3.2%; very coarse—0.8%. *Volume of temper:* average—30.9%; range—24.3 to 41.5%.

Clay. Olive or deep red-brown in transmitted light; generally isotropic, oxidized areas occasionally weakly birefringent. Refractive index varies from 1.550 to 1.564.

Physical properties. *Color.* Oxidized margins, usually less than one-third the thickness of the vessel wall, range through 11″, 13″ and 15″ (Vinaceous-Tawny, Orange-Cinnamon and Cinnamon). Cores are 15‴″ to 15‴″b (Mouse Gray to Light Mouse Gray). Completely oxidized sherds are 11″ to 13″ (Vinaceous-Tawny to Orange-Cinnamon), but these often have cores which are slightly lighter and more orange than the margins, 13″a being typical and 1‴″b (Light Purple-Drab) exceptional. A distinct paste of rare occurrence has cores paler than 15‴″f with margins of 17‴d (Vinaceous-Buff). Oxidized to 850° C. for 30 minutes. The original margin colors of 11″, 13″ and 15″ are the fully oxidized paste colors. Refired to 1200° C.—7″m, 9″m and 5‴m (Chocolate, Burnt Umber, and Seal Brown). *Hard-*

ness. 4, less frequently 4.5. Refired to 1200° C.—7+. *Modulus of Rupture*. Average—154 kg. per sq. cm.; range—138 to 179 kg. *Strength of Vessel Walls*. Average—27 kg. per 2.5 cm.; range—23 to 35 kg. *Apparent Porosity*. Average—23.6 %; range—18.5 to 28.6%. Refired to 1200° C.: average—5.5%; decrease—76.7%.

Slip. The slip is frequently so thin and blends so well with the color of the oxidized paste that it cannot be detected with a 10-power hand lens. In thin section, however, there is clearly visible a distinct coat of clay which has a higher refractive index, brighter color and finer texture than the paste and although the most doubtful specimens were examined microscopically no unslipped sherd was found. *Color*. The majority of specimens approximate 7'i (Vinaceous-Rufous) or 9'i (Ferruginous), the color usually being slightly more grayed and a little paler than either of these; 7'k (Hay's Russet), 7'' (Terra Cotta) and 10'i occur occasionally. Imperfectly oxidized slips are 11'' (Vinaceous-Tawny) to 11''i (Pecan Brown) and 17''' (Wood Brown). Refiring for 30 minutes at 850° C. in an oxidizing atmosphere does not change the color of the fully oxidized slips. Refired to 1200° C. the color becomes 9''k (Walnut Brown) or 7'k (Hay's Russet). *Hardness*. 4 to 5.5. Refired to 1200° C.—7. *Thickness*. 0.03 to 0.06 mm. *Finish and wear*. Slips are evenly and uniformly smoothed with horizontal strokes, but surfaces are never highly lustrous. Fine crazing is very rarely noted. Evidences of abrasion are exceptional but minute spalling is sometimes seen. *Optical Properties*. Clay is dark brown in transmitted light, pale orange in incident light, and dark red under crossed nicols. Refractive index—1.567 to 1.573. The texture is very fine and mineral inclusions were not detected.

Glaze. *Composition*. The glaze is a lead-silica glass, colored principally by manganese and containing a variable amount of iron, alumina, alkalis and other substances derived from the clay or introduced with the flux. *Refractive index of glass*. 1.701 to 1.778, rarely as high as 1.800. *Color* is typically black; very thin glazes and the transparent streaks between flocculent patches of pigment are of various shades of brown affected by underlying slip or clay color—1''''m (Blackish Brown [1]), 5'''m (Seal Brown), 9'''m (Light Seal Brown), 11'm (Chestnut-Brown); where dull and unvitrified—1'''''m (Sooty Black). In thin section the glass appears pale green or yellowish green, occasionally colorless, often masked by opaque black inclusions. *Texture and vitrification*. The glaze of fourteen of the thirty-eight bowls of the Pecos collection is well vitrified and lustrous; on the remainder it is dulled in part or entirely by one or more of a number of common defects. Vitrified surfaces are generally semimatte in appearance and rarely highly lustrous. Dullness and slight roughness of texture are caused by fine bubbles and inclusions, by broken blisters and by incomplete vitrification. Bubble rims are usually sharp, the bubbles either having been broken after firing or toward the end of firing when there was insufficient time for them to melt down. A distinctive texture is produced by the flowage of glaze from blisters broken during firing. Occasionally the glaze has a frosted or etched appearance, and rarely the surface is roughened by minute conchoidal flaking. A characteristic defect is beading, in which the glaze draws together in globules or ridges exposing the unglazed slip in irregular lines between the thick patches of glaze. Glaze is beaded on 24% of the entire Glaze I Red bowls of the Pecos collection. Brush strokes are noticeable on 31% of the bowls of the collection.

Crazing is very exceptional. *Hardness.* 5.5 to 6. *Solubility.* Attacked slowly by 1:1 hydrochloric acid. A white or yellowish precipitate is left from solution. *Thickness.* 0.03 to 0.05 or 0.08 mm. Thicker parts of beaded glaze—0.11 mm. *Inclusions.* Particles of pigment held in suspension usually form flocculent masses. The particles are angular, 0.003 mm. in diameter and tend to collect in patches and to migrate to the surfaces leaving a zone of clear glass at the contact of glaze and clay. Quartz grains were present in one-third of the sections examined. They vary from 0.08 to 0.14 mm. in diameter and produce a rough surface.

Firing. Calcite was found in one of the twenty-four sherds thin sectioned. Approximately one-quarter of the sherds are flaked by the action of lime.

The color of both slip and paste margins indicates an oxidizing atmosphere, but such conditions were rarely maintained long enough completely to oxidize the paste.

GLAZE I YELLOW

Megascopic observations. The paste is very similar in color range and texture to that of Glaze I Red. Opaque white rock fragments are visible in two-thirds of the sherds and contrast particularly well with the red orange color of the oxidized pastes.

Temper. Glaze I Yellow, is largely rock tempered; the rock, however, is less variable than in Glaze I Red. The fine textured diorite found in Glaze I Red preponderates and the porphyries are principally of the augite hornblende type. Basalt and sherd temper are very rare.

Texture. Average grain size—0.16 mm. in diameter; range—0.13 to 0.20 mm. Maximum grain size: average—0.99 mm.; range—0.48 to 1.6 mm. Average grading: Very fine—34%; fine—52%; medium—11.5%; coarse—2.8%. *Volume of temper:* average—30.7%; range—24.0 to 36.8%.

Clay. Color in transmitted light is gray to olive brown, oxidized areas are red orange. The clay is generally isotropic. *Refractive Index* between 1.550 and 1.564.

Physical properties. *Color.* Although the range in paste color is similar to that of Glaze I Red the proportion of completely oxidized sherds is higher, being nearly one-third of the total. A few specimens are uniform gray either 15''''b (Light Mouse Gray) or Light Neutral Gray. Cores of 17'''' (Drab) are occasionally found. A distinct paste is 17'''f (Tilleul-Buff) and sometimes has margins of 15''d (Light Pinkish Cinnamon). Oxidized at 850° C. for 30 minutes—11'', 13'' and 15'' (Vinaceous-Tawny, Orange-Cinnamon and Cinnamon) the oxidized margins being fully oxidized paste colors. Refired to 1200° C.—7''m, 9''m and 5'''m. (Chocolate, Burnt Umber and Seal Brown). The pastes originally 17'''f becomes 17'''b (Avellaneous). *Hardness.* 4. Refired to 1200° C.—7+. *Modulus of Rupture.* Average—139 kg. per sq. cm.; range—118 to 172 kg. *Strength of Vessel Walls.* Average—27 kg. per 2.5 cm.; range—19 to 36 kg. *Apparent Porosity.* Average—24.9%; range—21.0 to 27.2%. Refired to 1200° C.: average—11.5%; decrease—53.9%.

Slip. *Color.* The clearer colors are 15''f (Pale Pinkish Cinnamon) to 17''e and occasionally 13''f (Pale Cinnamon-Pink); the more modified colors, 17'''d (Vinaceous-Buff) to 17'''e, are equally characteristic. A whitish slip, paler than 15''''f

(Pallid Mouse Gray) also occurs. Oxidized at 850° C. for 30 minutes, the fully oxidized colors are unchanged but grayed 17'''e becomes 17''e. Fired to 1200° C.—the color becomes 19'''d. *Hardness.* Generally 5 or slightly under, occasionally 6. Refired to 1200° C.—7+. *Thickness.* On the majority of specimens 0.05 to 0.14 mm.; occasionally as thin as 0.03 mm., the reddish paste then shows through in streaks and on higher areas which always receive a thinner coat. *Finish and Wear.* Uniformly smoothed with horizontal strokes but rarely highly lustrous and marks of the polishing stone are seldom seen. Abrasion is exceptional but flaking and fine crazing occur occasionally. *Optical Properties.* In transmitted light the clay is pale olive or gray, in incident light very pale yellow. Isotropic. Refractive Index between 1.553 and 1.560. Contains numerous fine angular grains of quartz, 0.01 to 0.02 mm. in diameter.

Glaze. *Composition.* A lead-silica glass colored by a variable amount of manganese and iron. *Refractive Index* only exceptionally exceeds 1.800. *Color.* Typically very dark brown to black. The browns, usually mottled with patches of opaque black pigment, include 13m (Argus Brown), a step blacker than 15m (Brussels Brown), 11'm (Chestnut-Brown) and 15'm (Prout's Brown). The unusual lighter colors are 19'k (Buffy Citrine), 21'i (Olive Lake), 21''k (Buffy Olive), and 15''k to m (Snuff Brown to Bister). Thin or unvitrified glaze is 17'''' (Drab) and glazes dulled by broken blisters are 17'''k to m (Olive-Brown to Clove Brown), 17'''' to 17''''i (Drab to Hair Brown) and 13''''i (Benzo Brown). Viewed microscopically the glass usually appears light brown, occasionally it is pale olive green. *Texture and Vitrification.* Of the 63 entire bowls in the Pecos collection, 24% had a well vitrified smooth glaze, 54% were blistered, 19% matte from thin application and 3.1% dull from incomplete vitrification. Seventeen per cent had some encrustation. The well vitrified glaze generally attains a higher luster than that of Glaze I Red. The glaze on approximately half of the specimens in the collection had spread slightly beyond the line of application but so slightly as to be barely noticeable. Running of the glaze is very exceptional and crazing is also rare. Brush strokes could be detected on 36% of the bowls in the collection. *Hardness.* Varies from 5.5 to 7, the majority of specimens are 6 to 6.5. *Solubility.* Slightly over one-third of the specimens tested were readily soluble in 1:1 hydrochloric acid, the remainder were attacked very slowly. *Thickness.* Frequently varies from 0.03 to 0.11 mm. on a single specimen. Unusually thick lines are 0.14 mm. *Inclusions.* Flocculent patches of minute black opaque inclusions are characteristic. Fine, subangular grains of quartz and feldspar are rare.

Firing. No calcite was found in the twenty-nine thin sections studied. Four sherds in a representative group of twenty were flaked by the action of lime.

Red brown paste margins indicate that the firing atmosphere was generally oxidizing.

LOCAL GLAZE I RED

Megascopic observations. The paste is friable and sherds break with an irregular uneven fracture. Sand temper, with a scattering of sandstone fragments, is visible in most sherds. Minute flakes of mica are noticeable, especially on surfaces exposed by wear of the slip.

Except in very fine-textured pastes, this subtype can be distinguished from poorly made Glaze I Red by megascopic examination of paste alone. The typical Glaze I temper, angular fractures of rock with white feldspar crystals and black specks of hornblende or augite, is not easily confused with stream sand in which grains of clear quartz and flakes of mica are conspicuous. The color of the pastes also differ, that of Glaze I Red being characteristically clearer and lighter than that of the Local Glaze I Red.

Temper. The majority of sherds are tempered with sand evidently derived from disintegrated or pulverized sandstone or siltstone. Fragments of sandstone are common and are composed of grains of the same size, shape and mineralogical composition as the separate grains in the paste. Fragments of cementing material not infrequently adhere to these free sand grains. The sandstone fractures in different sherds vary in texture and in cement. Argillaceous and calcareous cements are both common but examples of these are rarely found in the same sherd though occasionally a very fine-textured kind with ferruginous cement is associated with either type. The same minerals occur in all three types. Quartz is always more abundant than the feldspars. The latter, which include microcline and acid plagioclase, are usually considerably grayed by decomposition and alteration to sericite mica is sometimes noticed. Flakes of a pale green mica are common. Of rare occurrence are small grains of green hornblende, blue green tourmaline, zircon, magnetite and garnet. Grains are angular to subangular.

A few sherds are tempered with stream sand instead of sandstone but igneous rock was not found. One exceptional paste contains fragments of tuff in addition to a micaceous sand. The neutral gray paste is very fine and dense. The tuff occurs in lumps composed of forked and rod-like pieces of glass in a dark matrix. Fragments of tuff are also distributed in the paste. The temper is exceptional because it contains more sand than tuff.

Texture. Average grain size—0.13 mm. in diameter; range—0.10 to 0.16 mm. Maximum grain size—0.90 mm.; range—0.64 to 1.12 mm. Average grading: very fine—43.2%; fine—54%; medium—3.6%; coarse—1.2%. *Volume of temper:* average—29.1%; range—25.4 to 34.9%.

Clay. Dark brown in transmitted light; isotropic. *Refractive Index* between 1.550 and 1.564.

Physical properties. *Color.* The paste of this type is either oxidized on the surfaces or completely oxidized, but the colors are all dark and dull. The oxidized colors range from 9″i and 11″i to 13‴i (Cacao Brown and Pecan Brown to Army Brown) and cores vary from Neutral Gray to 15⁗ and 15⁗k (Mouse Gray and Dark Mouse Gray). Margins are generally less than a third the thickness of the vessel wall. Sherds of the same period, but with a very poor quality white slip instead of the fugitive red wash, have the same range in paste color but tend to darker shades, and the margins are less noticeable. The tuff-tempered sherd has a Pallid Neutral Gray core with inner margins of 13‴i to k (Army Brown to Natal Brown) and outer margins of 17⁗b to 17‴ (Light Drab to Wood Brown). *Hardness.* 3.5. Refired to 1200° C.—5 to 5.5. *Modulus of Rupture and Strength of Vessel Walls.* Not determined because of limited number of sherds available for study. *Apparent*

Porosity. Average—25.9%; range—24.6 to 28.6%. Refired to 1200° C.: average—17.1%; decrease—34.0%. The porosity of the sherd containing tuff was 22.4%.

Slip. *Color*. 7″ (Terra Cotta) less gray; imperfectly oxidized 11″i (Pecan Brown). *Hardness*. 2 to 3. *Thickness*. 0.03 mm. in the few unabraded specimens examined. *Finish and wear*. The slip is so soft that the greater part of it is worn off from most specimens and the patches which remain are dulled by abrasion. The rare unabraded areas are faintly lustrous and show horizontal smoothing strokes.

Glaze. *Refractive index*. There was insufficient glass in the glazes examined to obtain a measurement. *Color*. The most completely vitrified specimens are blacker than 1′′′′′m (Sooty Black). Imperfectly vitrified or encrusted glazes are 15′′′′′k (Dark Mouse Gray) and 1′′′′′m. *Texture and vitrification*. The glaze on only one or the twenty-five entire specimens of the Pecos collection was well vitrified. Sintered or incompletely vitrified glazes are common, as are also those dulled by defects such as blistering. Approximately half of the specimens are incrusted with a gray of whitish deposit. Brush strokes can be traced on a fifth of the bowls but spreading is rare. Crazing is exceptional. *Hardness*. 5 to 6.5. *Thickness* generally 0.02 to 0.06 mm.; 0.10 to 0.15 mm. in blistered areas. *Solubility*. The glaze of approximately half of the specimens is readily attacked by 1:1 hydrochloric acid, that on the remainder is only slowly attacked. *Inclusions*. Minute angular black inclusions are characteristic.

Firing. Calcite is present in three of the eight specimens sectioned. No example of calcined carbonate of lime was found.

The color of slip and paste margins indicates that the atmosphere was generally oxidizing.

GLAZE II

Megascopic observations. Texture of the paste varies within wide limits but it is generally possible with a 10-power lens to distinguish sand grains and the exceptional sherds tempered with igneous rock can usually be identified megascopically. The fracture is irregular and the paste friable.

Temper. Either siltstone or stream sand. Siltstone occurs in over half of the sherds and is identical in mineral composition and texture with that found in Local Glaze I Red. The siltstone fractures usually have an argillaceous cement, calcareous cement being very rare. The stream sand is noticeably coarser in texture and not as well assorted as the grains of the siltstone. An exceptional sherd contained abundant pale green mica.

Three sherds in a group of thirty-two representative sherds were tempered with igneous rock. The rock in two of these specimens is diorite and in the third porphyry.

Texture. Average grain size—0.13 mm. in diameter; range—0.07 to 0.22 mm. Maximum grain size: average—0.86 mm.; range—0.24 to 1.84 mm. Average grading: very fine—53.6%; fine—39.2%; medium—5.6%; coarse—1.6%. *Volume of temper:* average—28.7%; range—18.2 to 36.2%.

Clay. Dark gray or olive brown in transmitted light, oxidized areas red brown. Isotropic. Refractive Index between 1.550 and 1.564.

Physical properties. *Color.* The color of the majority of sherds ranges between 15''''f (Pallid Mouse Gray) and Pale to Light Neutral Gray *d* to *b*. A few sherds are 15'''' (Mouse Gray), but the grays of this type are generally paler than those of Local Glaze 1 Red. Over half of the gray sherds have oxidized margins, generally narrow and sometimes present only on the exterior. The typical color of the oxidized paste is 13'' (Orange-Cinnamon); 17''' (Wood Brown) is rare. Margins of darker gray sherds are 13'''i to k (Army Brown to Natal Brown). The few completely oxidized sherds are 11''i to 9''i (Pecan Brown to Cacao Brown). Oxidized at 850° C. for 30 minutes—11'' to 13'' (Vinaceous-Tawny to Orange-Cinnamon). Refired to 1200° C.—7'k or 7''i (Hay's Russet or Vinaceous-Russet). *Hardness.* 4. Refired to 1200° C.—5 to 5.5. *Modulus of Rupture.* Average—198 kg. per sq. cm.; range—179 to 226 kg. *Strength of Vessel Walls.* Average—37.5 kg. per 2.5 cm.; range—19 to 57 kg. *Apparent Porosity.* Average—23.5%; range—18.4 to 26.3%. Refired to 1200° C.: Average—19.1%; decrease—18.7%.

Slip. *Color.* The clearer colors are 15''d to 17''d (Light Pinkish Cinnamon to Pinkish Buff) slightly grayed and 17'''e. An exceptionally clear slip matches 13''c. Whitish slips are paler than 17'''f, 17''''f and 13''''f (Tilleul-Buff, Pale Drab-Gray and Pale Ecru-Drab). Reduced colors include Neutral Gray *i* to *d*, and 21''''d to f (Smoke Gray to Pale Smoke Gray). Oxidized at 850° C. for 30 minutes—the majority of specimens change to 15''b to d (Pinkish Cinnamon to Light Pinkish Cinnamon), rarely 13'' (Orange-Cinnamon) and 17''d (Pinkish Buff). Soft whitish slips become 15''f to 17''f (Pale Pinkish Cinnamon to Pale Pinkish Buff). Refired to 1200° C.—19''b (Chamois). *Hardness.* The majority of specimens are 3.5 to 4, a few are 4.5 and one exceptional piece of a distinct clay is 5+. *Thickness.* 0.02 to 0.10 mm. An exceptionally thick specimen measured 0.28 mm. The variation in thickness in a single specimen is often as great as 0.05 mm. *Finish and Wear.* The majority of specimens are uniformly smoothed with horizontal strokes. The surface is fine textured and slightly but never highly lustrous. Occasional specimens were poorly finished and surfaces remained uneven after slipping and smoothing. Exceptional crazing is due to defects of the paste. The softer slips are badly abraded. *Optical Properties.* Light to dark brown or olive brown in transmitted light, pale to bright yellow or light orange, rarely whitish in incident light. Generally weakly birefringent, a few isotropic. Refractive index—majority between 1.560 and 1.564, a few 1.549. Texture variable, clay usually contains a few quartz grains 0.01 to 0.03 mm., rarely as coarse as 0.08 mm., in diameter.

Glaze. *Composition.* Basically a lead silica glass colored by a variable amount of manganese and iron. *Refractive Index* is between 1.778 and 1.850. Two-thirds of the specimens examined exceeded 1.800 but were definitely under 1.850 and one-third were under 1.800. *Color.* Well vitrified specimens are commonly dark brown or nearly black. The browns include 11m (Auburn), 13'k (Russet), 15'm (Prout's Brown), 13''m (Warm Sepia) and 15''m (Bister). They are often mottled or streaked with black. The darkest specimens are blacker than 1''''m (Sooty Black). Applications which are dull because of blistering or penetration usually range in color from 13'''' to 13''''m (Cinnamon-Drab to Fuscous-Black), but occasionally are 17''''i (Hair Brown). Green, which is exceptional, was noted in glaze which spread in small

trickles from the main body and collected in spots over the light slip. The color varied from 27″i to 25‴i (Rainette Green to Deep Grape Green), the main body of the glaze being 15′m (Prout's Brown) and darker where thick to 21″″ (Grayish Olive) where thin. Viewed in thin section the glass is characteristically light brown. *Texture and Vitrification.* Only a small proportion of the specimens have smooth, well vitrified glaze. Approximately half of the entire bowls are roughened by fine, usually broken, blisters which vary in diameter from 0.05 to 0.10 mm. Many otherwise well fluxed specimens are blistered in restricted areas; on others the entire surface is honeycombed with fine broken bubbles. Approximately a quarter of the entire specimens are roughed by inclusions; on 18% of the entire bowls of the Pecos collection the glaze is incompletely fused and in an equal proportion it is partly dull because of thinness of application. The glaze spread or ran on approximately one-quarter of the specimens and the same proportion show brush strokes. Crazing occurs only on the lighter colored, thicker parts of the glaze; it was noted on 10% of the vessels of the collection. It is described by March's—"Semi-crystalline"[1] and the distance between lines varies from 0.1 to 0.5 mm. *Hardness.* Well vitrified specimens are generally 5.5 rarely 6.5. *Solubility.* The majority of specimens are readily attacked by 1:1 hydrochloric acid, a yellow precipitate being left. *Thickness* is variable with extremes of 0.01 and 0.08 mm. excluding exceptionally thick gathered patches and drops. The majority of glazes are between 0.03 and 0.08 mm. *Inclusions.* Minute black angular inclusions (0.003 to 0.004 mm. in diameter) are not uncommon and flocculent patches of black opaque material are characteristic. Fine inclusions of quartz are seen in some specimens and also streaks of grayish cloudy material.

Red paint. *Color.* Fully oxidized paints are 7′k (Hay's Russet), 5′i (Dragon's-blood Red) grayed, 7′i (Vinaceous-Rufous) and 5′k (Brick Red). Imperfectly oxidized they become 9″i to 11″i (Cacao Brown to Pecan Brown), 9′l (darker than Kaiser Brown) and in extreme reduction 13‴m (Bone Brown). Fully oxidized colors are not modified by refiring to 850° C. *Hardness.* 2.5 and 3.5 to 4. The soft paints are badly abraded and where the polish has been removed are easily rubbed with the finger. *Thickness.* Majority of specimens are 0.05 to 0.08 mm.; extremes are 0.03 and 0.10 mm. *Finish.* Smoothed with strokes running longitudinally with the design. Rough streaks are often left between strokes and surfaces are never highly lustrous. The paint never crazes but is often badly abraded and may even be completely worn. *Optical Properties.* Opaque, bright red orange in incident light. Very fine textured; contains no mineral inclusions larger than 0.01 mm. in diameter.

Firing. Mineral inclusions give little indication of firing temperature. Calcite was not noted in the thin sections examined and only two sherds in a representative group of fifty-three were flaked by the action of lime.

Color of slip and paste margins indicate an oxidizing atmosphere.

GLAZE III

Megascopic observations. Paste texture is variable, some sherds are dense, fine and homogeneous while others are medium grained and somewhat sandy in

[1] 1934, p. 41.

appearance. The tempering material frequently cannot be identified megascopically in the former type while in the latter sand grains are plainly visible. The rare rock-tempered sherds cannot invariably be distinguished megascopically but usually the porcelain-like fragments of feldspathic rock are noticeable. The fracture is earthen and irregular.

TEMPER. The majority of sherds are tempered with either siltstone or stream sand. The proportion of siltstone is high, 90% of the sherds examined containing some fractures of either siltstone or very fine sandstone. The siltstone in one-fifth of the sherds has a calcareous cement, in the remainder the cement is argillaceous. Texture and mineralogical composition of both stream sand and siltstone do not differ from the types described except in the prominence of a very fine siltstone containing numerous flakes of dark brown biotite.

An exceptional sherd contained a high percentage of pale green mica apparently derived from a mica shist. In a group of seventy-six representative sherds six were found which were tempered with igneous rock, two of these being diorite and four hornblende augite porphyry of intermediate composition.

TEXTURE. Average grain size—0.11 mm. in diameter; range—0.09 to 0.17 mm. Maximum grain size: average—0.94 mm.; range—0.56 to 1.28 mm. Average grading: very fine—64.4%; fine—33.2%; medium—2.4%. *Volume of temper:* average—25.7%; range—16.0 to 34.2%.

CLAY. In transmitted light dark gray or olive brown, occasionally opaque; oxidized areas red brown. Generally isotropic. Refractive index majority of specimens between 1.550 and 1.560.

PHYSICAL PROPERTIES. *Color.* Pastè colors are rather uniformly distributed between 15''''i (Deep Mouse Gray), 15'''' (Mouse Gray) and 15''''f (Pallid Mouse Gray). The shade and lighter tint, however, preponderate slightly over the intermediate tone. Approximately one-third of the sherds show some degree of oxidation, generally irregular margins, one-third or more of the thickness of the vessel wall. The usual oxidation color is 9'k (Kaiser Brown), rarely 17''' (Wood Brown) and 15''b (Pinkish Cinnamon). Oxidized for 30 minutes at 850° C.—11'' to 13'' (Vinaceous-Tawny to Orange-Cinnamon), 13''b (Vinaceous-Cinnamon) and 14''b. Refired to 1200° C.—7'k (Hay's Russet) or 7''i (Vinaceous-Russet). *Hardness.* 3.5 to 4, the majority are under 4. Refired to 1200° C.—5 to 5.5. *Modulous of Rupture.* Average—138 kg. per sq. cm.; range—103 to 166 kg. *Strength of Vessel Walls.* Average—30 kg. per 2.5 cm.; range—19 to 44 kg. *Apparent Porosity.* Average—24.6%; range—21.2 to 28.7%. Refired to 1200° C.: Average—18.9%; decrease—23.2%.

SLIP. *Color.* The paler and clearer colors include 17'''f to e (Tilleul-Buff to a half tone deeper), 19''f to e (Cartridge Buff and a half step deeper), 15''f to e (Pale Pinkish Cinnamon and a half tone deeper) more grayed. Exceptionally pale slips are whiter than 17'''f and 19'''f. Of rare occurrence are warmer colors, 13''d and 17'''d (Light Vinaceous-Cinnamon and Vinaceous-Buff). A pinkish slip, 13'''d (Light Vinaceous-Fawn) is rare as is also 15'''e. Interiors are frequently grayed by reduction; the color range includes 17'''f (Tilleul-Buff) grayed, 17''''d (Drab-Gray) and 15''''d to m (Pale Mouse Gray to Blackish Mouse Gray). The rare reddish slips are 7'' (Terra Cotta), 7''i (Vinaceous-Russet), 9'' (Testaceous), 11''a (a half step

paler than Vinaceous-Tawny) and 13″b (Vinaceous-Cinnamon). Reduced slips are 13‴ (Fawn Color), more completely reduced 17⁗ to 17⁗⁗i (Drab to Hair Brown). Oxidized at 850° C. for 30 minutes the light slips become 15″d to e (Light Pinkish Cinnamon and a half tone paler). The change in the clearer reds is barely perceptible, others became 11″a to 11″b and 13″ to 13″b (Onion-skin Pink or a half tone deeper and Orange-Cinnamon to Vinaceous-Cinnamon). The Pinkish slip refires to 9″d (Vinaceous-Pink). Refired to 1200° C. the light slips become 19″d (Cream-Buff) usually slightly grayed and 19‴b. *Hardness.* The light slips fall into two groups, one of which is 4 to 4.5 and shows very little if any abrasion whereas the second group is badly worn, and varies in hardness from 2.5 to 3.5 the majority being 2.5 to 3. These slips usually fall within the lighter color range of the group. The reddish slips are between 3.5 and 4.5. *Thickness.* 0.01 to 0.06 mm. on the majority of sherds, thicker slips are 0.06 to 0.11 mm. and an exceptional one measured 0.23 mm. in the thickest parts. *Finish and wear.* The surface is generally even and the slip well smoothed with approximately horizontal strokes; either slightly lustrous or dull; crazed only when unusual firing conditions have caused cracking of the paste. Soft badly abraded slips are common, the interiors usually being considerably more worn than the exterior, in extreme examples the slip is entirely gone. *Optical Properties.* Gray or light brown in transmitted light. Weakly birefringent or isotropic. Cream or pale yellow in incident light. Refractive index generally 1.560 to 1.564, occasionally as low as 1.550. Contains a few quartz grains 0.01 to 0.05 mm. in diameter.

Glaze. *Composition.* Basically a lead silica glass colored by a variable amount of manganese and iron. *Refractive Index* of the majority of specimens is near 1.800. A few are as high as 1.850 and a few are between 1.737 and 1.778. *Color.* Nearly colorless as well as dark glazes are found, also a few odd greens. The dark glazes are 11m (Auburn), 17m (Raw Umber), 11′m (Chestnut-Brown), 15′k (Cinnamon-Brown), 17′k to m (Dresden Brown to Mummy Brown), 17″k to m (Saccardo's Umber to Sepia) and blacker than 1⁗⁗m (Sooty Black). Glazes with little pigment are 19″b, 19″, 19″i (Chamois, Honey Yellow and Isabella Color). Light glaze over red paint becomes 17′m (Mummy Brown) also 13′k and 17′k (Russet and Dresden Brown), rarely 9k (Burnt Sienna). The greenish glazes are: 21m to 21k (Dark Citrine to Citrine), 23′k (Serpentine Green), 21′m (Olive-Citrine) and 21″m (Olive). Glaze around pits is 19‴b and 21‴ (Dark Olive-Buff). Dull imperfectly vitrified glazes are 13‴k to m (Natal Brown to Bone Brown), 13⁗i to k (Benzo Brown to Fuscous), 17⁗i to m (Hair Brown to Chaetura Drab) and 15⁗⁗i (Deep Mouse Gray). Color of glass viewed microscopically is light brown. *Texture and vitrification.* The glaze is smooth, lustrous and well vitrified on less than a fifth of the 105 whole bowls of the Pecos collection. Defects causing a dull appearance are, in order of their frequency, blistering, thin application, sintering (underfiring) and inclusions. Incrustation is also common. Darker parts of the glaze often have a misted appearance. A few specimens are flaked and one shows slight gathering of the glaze. Approximately one-quarter are crazed. The glaze had spread or run on one-third of the specimens and one-fifth show brush strokes. *Hardness.* The majority are 5.5 to 6, a few are 4.5 and an equal number 7. *Solubility.* Equally divided between those

which are readily soluble in 1:1 hydrochloric acid and those only slightly soluble. *Thickness* varies between 0.03 and 0.14 mm. The majority of specimens are between 0.03 and 0.08 mm. *Inclusions*. Dark flocculent masses, and spots of partially dissolved pigment are common. The minute dark opaque sharply angular inclusions occur less frequently. Small grains of quartz and feldspar are found in a few specimens. In some instances they appear to have been derived from slip or paste which has been attacked by the glaze, and in others to have occurred originally in the glaze.

Red paint. *Color*. Clearest colors are 7′j (a step lighter than Hay's Russet), rarely 5′k (Brick Red). The majority are browner and duller from unfavorable firing atmosphere. These include 7′i (Vinaceous-Rufous), 7″k (Cameo Brown), 13‴i (Army Brown), through 9‴m (Light Seal Brown) to 13⁗k and m (Fuscous and Fuscous-Black). Colors are occasionally yellower, 15″ (Cinnamon), 13″ and 13″b (Orange-Cinnamon and Vinaceous-Cinnamon). Reduction of paint frequently appears to have been independent of reduction or smudging of slip; paint may be 9″i (Cacao Brown) where there is very noticeable graying of the slip, whereas the slip surrounding some of the very dark gray paints may not be noticeably discolored. The clearest colors are commonly on the creamy slips. *Hardness*. Generally 3.5 to 4. A few are 2.5 and the dark reduced specimens usually exceed 4, a few approach 5. *Thickness*. 0.03 to 0.08 mm. on the majority of sherds, very rarely 0.23 mm. *Finish*. Indifferently smoothed with strokes running longitudinally with the design. Moderately lustrous with dull unpolished streaks. A relatively even application, sometimes worn off or peeled with slip, and occasionally crazed.

Firing. Calcite was not found in the thin sections examined. Two in a group of seventy-five representative sherds were flaked by the action of lime.

The color of slip and paste margins indicate an oxidizing atmosphere.

GLAZE IV

Megascopic observations. The paste is characteristically fine and homogenous in texture. A scattering of siltstone fractures and creamy white specks of limestone can be detected with a 10-power hand lens in the majority of sherds. The fracture is irregular.

Temper. Siltstone fractures are present in all but a few exceptional pastes. The texture and grading of the siltstone is very uniform. It is generally (70% of the specimens examined) cemented with argillaceous material, though a calcareous cement is also found. Mineralogically it does not differ from the specimens previously described.

An exceptional sherd from a shouldered bowl has an extremely fine, nearly black paste which is apparently untempered as it contains only a scattering of very fine grains of quartz and feldspar and a few flakes of mica. A magnification of 380 diameters reveals, in addition to the mineral inclusions, minute particles of volcanic glass. Six of the fifty sherds examined microscopically were tempered with igneous rock; in all instances a hornblende augite porphyry of intermediate composition.

Texture. Average grain size—0.12 mm. in diameter; range—0.08 to 0.17 mm. Maximum grain size: average—1.18 mm.; range—0.80 to 1.60 mm. Average

grading: very fine—58.4%; fine—36.0%; medium—5.6%. *Volume of temper:* average—37.0%; range 30.4 to 43.5%.

Clay. Dark gray or brown in transmitted light, occasionally opaque; oxidized areas red brown. Generally isotropic. Refractive index majority of specimens between 1.550 and 1,560.

Physical properties. *Color.* Nearly two-thirds of Glaze IV sherds are 15'''''b to f (Light Mouse Gray to Pallid Mouse Gray), occasionally with a narrow margin of 13'' (Orange-Cinnamon); one-fifth is deeper gray, approaching most closely Neutral Gray, and the remainder is oxidized with colors ranging from 13''b (Vinaceous-Cinnamon) to 15''b (Pinkish Cinnamon). Five sherds, all of which were rock tempered, had a distinct color range—oxidized margins of 17''d (Pinkish Buff) and cores of 15'''''f (Pallid Mouse Gray) or Carbon Gray 8. Oxidized at 850° C. for 30 minutes—13'', 13''a, or 12'' (Orange-Cinnamon, a half tone paler or a half tone redder). Refired to 1200° C.—7'k (Hay's Russet) or 7''i (Vinaceous-Russet). *Hardness.* 3.5 to 4; the harder sherds are more typical. Refired to 1200° C.—5 to 5.5. *Modulus of Rupture.* Average—161 kg. per sq. cm.; range—125 to 216 kg. *Strength of Vessel Walls.* Average—32 kg. per 2.5 cm.; range—21 to 49 kg. *Apparent Porosity.* Average—26.2; range—22.8% to 30.2%. Refired to 1200° C.: Average—19.8%; decrease—25.1%.

Slip. *Color.* The reddish and tan slips characteristic of Glaze IV are in marked contrast to the dirty whites common on Glaze II and III vessels. Glaze IV slips appear to exhibit a continuous gradation from red to tan but when the fully oxidized colors are brought out by refiring it is found that there are two distinct types, a true red and a paler yellower slip. Variable firing conditions and particularly incomplete oxidation in the original firing tend to confuse these two classes of slip. The clearer reds are commonly 9'' to 9''i (Testaceous to Cacao Brown) or 13''a (a half tone lighter than Orange-Cinnamon). The lighter more grayed colors which may be classed as tan preponderate over red. The former include 15'''b less gray, 17'''b (Avellaneous) and 13'''a. Exceptionally clear colors are 11' (Apricot Orange) grayed, 9'a (a half step lighter than Rufous), 9''b to a and 11''b to 13''b (Japan Rose to a half tone deeper and Onion-skin Pink to Vinaceous-Cinnamon). Whitish slips similar to the soft slips of Glaze III are grayer than 17'''d to f (Vinaceous-Buff to Tilleul-Buff). These are of rare occurrence. Oxidized at 850° C. for 30 minutes the clearer slips are unchanged, reduced reds become 11'' to 11''c (Vinaceous-Tawny to a half step paler than Onion-skin Pink), and the tans 13''d (Light Vinaceous-Cinnamon) or 13''d grayed. Refired to 1200° C.—7''k (Cameo Brown); rarely slightly clearer than 7''i (Vinaceous-Russet). Whitish slips—paler than 17'''''f (Pale Drab-Gray). *Hardness.* The majority of both tan and red slips are 4 to 4.5, a few are 3.5 and very rarely a red slip as soft as 3 is found. The rare whitish slips are 2.5 to 3. Refired to 1200° C.—5.5 to 6. *Thickness* of both tan and red slips is variable; the majority are 0.03 mm. or less, a few are 0.06 to 0.08 mm. and exceptional specimens are 0.14 to 0.23 mm. There is no marked difference in thickness of exterior as compared with interior slip. *Finish and wear.* Surfaces are even and generally well smoothed with horizontal strokes. Occasionally moderately lustrous but usually dull. Exteriors are not infrequently more lustrous than the interiors, suggesting that

the inner surface may be slightly worn, but peeling or deep abrasion is rare except in the whitish slips. Crazing is exceptional but upon close examination some specimens are seen to have fine lines running mainly in a horizontal direction. *Optical Properties.* Light slips. Tan to gray in transmitted light. Cream colored in incident light. Weakly birefringent or isotropic. Refractive index. Majority 1.564 to 1.567. Reddish slips. Dark brown in incident light. Isotropic. Refractive index 1.578.

Glaze. *Composition.* A lead silica glass colored by a variable amount of manganese and iron. *Refractive index.* Half of the specimens examined were between 1.800 and 1.850. The remainder were under 1.800 the lowest being 1.736. *Color.* Glaze is characteristically very dark brown or blackish. Many specimens are blacker than 1''''m (Sooty Black) and the browns are often streaked or splotched by black. The browns include: the range from 9m to 15m (Chestnut to Brussels Brown), 9'm, 13'm, 17'm (Carob Brown, Mars Brown, Mummy Brown) and 17''m (Sepia). The color of imperfectly vitrified glaze is the same as in Glaze III. Viewed microscopically the glass is light brown. *Texture and vitrification.* Of the entire bowls (76) of the collection, 15% had a well vitrified lustrous glaze, while 35% was dulled and roughened by broken blisters, and the remainder was lusterless because of thin application, granular inclusions or unbroken bubbles and incomplete vitrification. The glaze on 52% had spread though generally but slightly and only 8% had run. Brush strokes were noted on only 2%. The glaze of over half was encrusted. Crazing is uncommon, only 10% showing any evidence of crazing and these being the thicker lighter colored specimens. *Hardness.* The majority of specimens are 5.5 to 6, a few are slightly harder than 6 and a few are 5. *Solubility.* The specimens examined were equally divided between those which are very soluble and those which are only slightly soluble in 1:1 hydrochloric acid. *Thickness.* Varies from 0.01 to 0.20 mm. The majority are between 0.03 and 0.06 mm. *Inclusions.* Flocculent patches of dark opaque pigment are common, occurring in over half the specimens. An equal number are entirely opaque. Partially dissolved specks of pigment occur occasionally but minute angular sharply defined opaque inclusions are rare. Inclusions of quartz 0.05 to 0.14 mm. in diameter are found only rarely.

Red paint. Red paint was used on approximately half of the red slipped specimens and the slip and paint are frequently barely distinguishable. Red paint is much more commonly used on the tan slip with which it gives a pleasing contrast. *Color.* The clearest colors are 5'k (Brick Red), 7'k (Hay's Russet) and 7'i (Vinaceous-Rufous) more grayed. More common are the duller reds and browns which result from imperfect oxidation—9'' (Testaceous), 11'' (Vinaceous-Tawny), 9''k (Walnut Brown), 9''''i (Deep Brownish Drab), 7''m (Chocolate) and 5''''i to k (Vinaceous-Brown to Dark Vinaceous-Brown). Oxidized at 850° C. for 30 minutes the clearer colors are unchanged. *Hardness.* 3 to 3.5; when reduced 4.5. *Thickness.* 0.03 mm. or less on the majority of specimens, rarely as thick as 0.08 mm. *Finish.* Well smoothed with strokes which generally follow the direction of the design. Surface seldom highly lustrous. Crazing rare.

Firing. Calcite was not found in the thin sections examined. Two sherds in a group of fifty-three were flaked by the action of lime.

Color of slip and paste margins indicate that the atmosphere was generally oxidizing.

GLAZE V

MEGASCOPIC OBSERVATIONS. Examination with a 10-power hand lens generally leaves no doubt that the paste was sand tempered, for the subangular, preponderantly transparent or translucent grains are clearly visible and fine sandstone fractures can also sometimes be observed. Other inclusions occasionally detected are creamy patches of limestone and particles of dark brown or black furruginous material. The paste is characteristically soft and friable and the fracture irregular.

TEMPER. All of the Glaze V sherds examined were tempered with either siltstone or stream sand. Siltstone fractures were found in approximately three-quarters of the specimens examined. In the majority of these (78%) the siltstone had a calcareous cement, the remainder was cemented with argillaceous material. The mineralogical composition of the siltstone and stream sand is the same as that of preceding types. One sherd tempered with stream sand was distinguished by a peculiar corrosion, pitting and grooving of the feldspar and quartz grains.

TEXTURE. Average grain size—0.14 mm. in diameter; range—0.10 to 0.18 mm. Maximum grain size: average—1.36 mm.; range—1.20 to 1.60 mm. Average grading: very fine—50.0%; fine—40.8%; medium—8.0%; coarse—1.2%. *Volume of temper:* average—29.8%; range—21.9 to 39.0%.

CLAY. Brown or gray in transmitted light. Generally isotropic. Refractive index between 1.550 and 1.564.

PHYSICAL PROPERTIES. *Color.* Judged by color, sherds fall in several groups, although these intergrade to a certain extent and may be due primarily to difference in firing treatment rather than to paste composition. A little over half of the sherds are 15''''' to 15'''''i, (Mouse Gray to Deep Mouse Gray) and approximately one-third are lighter gray 15'''''d to f and Neutral Gray *d* to *f*. Neither of these groups shows any indication of surface oxidation in margin colors. The remainder of the sherds (20%) shows some degree of oxidation, either narrow to deep, irregular margins of 11''i (Pecan Brown) or more complete oxidation, sometimes with core margin variations in brown. Colors grade from 11''i (Pecan Brown) to 13'''i (Army Brown). The light and dark gray pastes appear to differ in texture, the lighter grays being finer and more sparsely tempered. The greater color contrast in the dark gray and brown sherds, however, undoubtedly contributes to this impression. While the color range of this type is the same as that of Glazes II, III and IV, the increased proportion of dark grays is marked. Oxidized at 850° C. for 30 minutes—9''i (Cacao Brown) and 11'' (Vinaceous-Tawny) grayed; occasionally 13'' (Orange-Cinnamon) less gray. Refired to 1200° C.—7'k (Hay's Russet) or 7''i (Vinaceous-Russet). *Hardness.* 4 to 4.5. Refired to 1200° C.—5 to 5.5. *Modulus of Rupture.* Average—156 kg. per sq. cm.; range—70 to 205 kg. *Strength of Vessel Walls.* Average—27 kg. per 2.5 cm.; range—10 to 41 kg. *Apparent Porosity.* Average—24.1%; range—19.3 to 31.6%. Refired to 1200° C.: Average—23.7%; decrease—1.6%.

SLIP. *Color.* Typically 17'''f to e (Tilleul Buff or a half tone deeper); exceptionally clear colors range from 15''e and f to 17''e and f. Grayed by reduction 21''''d

(Smoke Gray) and 15''''k (Dark Mouse Gray). Oxidized at 850° C. for 30 minutes. 17''d (Pinkish Buff). Refired to 1200° C.—19'''b. *Hardness.* Generally 3.5 to 4, rarely 4.5. Exceptionally soft slips, usually badly worn, are 2.5 to 3. Refired to 1200° C. 7.5. *Thickness.* interior 0.08 to 0.14 mm.; on the majority of specimens 0.11 to 0.14 mm. and frequently varying within these limits on a single specimen. Exterior 0.06 to 0.14 mm., in the majority 0.06 to 0.08 mm. *Finish and wear.* Smoothed with nearly horizontal strokes which seldom cover the surface uniformly, so that generally faintly lustrous streaks alternate with dull ones. Many poorly smoothed specimens have resulted from careless evening of the vessel surface. The slip on approximately one-fifth of the specimens is badly abraded. Crazing is exceptional. *Optical Properties.* Tan to gray in transmitted light; weakly to brightly birefringent. Refractive index. The majority of specimens fall within the range of 1.550 to 1.564. Contains a scattering of quartz grains 0.03 to 0.05 mm., rarely as coarse as 0.08 mm. in diameter.

Glaze. *Composition.* A lead silicate glass colored by iron and manganese. *Refractive index of glass.* The majority of specimens exceed 1.800 and one-third of those examined exceeded 1.850. *Color* of the glass is often highly variable, definite areas of darker color evidently being due to uneven distribution of the pigment before it was taken into solution. Black and very dark brown, most closely approaching 7m (Bay) and darker, occasionally 11m (Auburn) or 15m to 17m (Brussels Brown to Raw Umber) are typical. Lighter browns, 17'k (Dresden Brown) and 19'i (Old Gold), and olive, 19m (Medal Bronze), are exceptional. Green has been observed only around pits. Many of the well vitrified brown glazes are irridescent. *Texture and vitrification.* As there are few complete vessels in the Pecos collection observations were limited to sherds and neither the proportion of successful pieces nor the uniformity in vitrification could be recorded. The glaze on two-thirds of the sherds from general digging is well vitrified and highly lustrous. Approximately one-fifth of the glazes is blistered but a matte surface caused by incomplete vitrification is exceptional and dullness resulting from thin application is very rare. The glaze on two-thirds of the sherds is crazed. *Hardness.* 5.5 to 6.5, rarely 5. *Solubility.* Readily attacked by 1:1 hydrochloric acid. The precipitate is usually yellow. *Thickness.* 0.08 to 0.14 mm. on the majority of specimens. Exceptionally thin lines 0.03 mm.; thick parts 0.30 to 0.40 mm. *Inclusions.* Spots and masses of undissolved pigment occur but are not characteristic. Small grains of quartz and feldspar are rarely found.

Red paint. *Color.* Commonly 7'k (Hay's Russet) or varying a half step in intensity or hue from this color. Reduced 9'm (Carob Brown) and 9''''k (Dusky Drab). Oxidized at 850° C. for 30 minutes clearer colors are unchanged. *Hardness.* 3 to 3.5, when reduced 4.5. *Thickness.* Generally 0.01 to 0.05 mm. Exceptionally thick specimens are 0.11 mm. *Finish.* Well smoothed and faintly lustrous. Rarely crazed but frequently worn.

Firing. Calcite occurred in 8 of the 25 sherds thin sectioned. No example of calcined limestone was found in a representative lot of 53 sherds.

Clear slips and paints show that an oxidizing atmosphere usually prevailed at least during the final stages of firing, but such conditions were never maintained long enough fully to oxidize the paste.

GLAZE VI

MEGASCOPIC OBSERVATIONS. The paste is friable and the numerous medium and occasional coarse, opaque white and gray tempering fragments stand out plainly. Examination with a 10-power lens reveals many subangular translucent or transparent grains which raise doubt as to whether the paste was tempered with rock of sand. The fracture is irregular.

TEMPER. The majority of sherds are tempered with igneous rock but in contrast to Glaze I Red the texture and composition of the rock is relatively uniform. The rock is a porphyry and scattered through the paste are crystals of feldspar, hornblende and augite and fragments of microcrystalline groundmass often containing phenocrysts. The principal feldspar is andesine. It exhibits marked zoning and is frequently considerably altered particularly at the centers of crystals. Altered areas are dark brown and patches of calcite are sometimes formed. Potash feldspar is represented by microcline but fragments are rare and none were seen in the rock groundmass. In most sections a few large grains of quartz occur but they are more rounded than the other mineral or rock inclusions and primary quartz was not found in the rock fractures. It is improbable that these quartz grains occurred originally in the clay for they are too coarse. It is possible that sandstone metates were used for grinding the rock temper and that grains of quartz were rubbed loose from them and so included with the temper. The hornblende crystals are olive to reddish brown in color. They are often considerably altered and in extreme cases are completely replaced by granular, black, opaque material. The augite is very pale green and rarely altered. It occurs in approximately the same proportion as the hornblende, though one or the other may preponderate in the rock of a given sherd. Grains of magnetite also occur. The groundmass is cryptocrystalline. It varies in color in transmitted light from pale gray to brown and is sometimes considerably altered.

Three sherds were found, among the twenty-four sherds sectioned, which were sand tempered. Only one of these contained the type of siltstone characteristic of other Pecos Glazes. One of the two distinctive specimens was tempered with very fine well assorted silt in which were numerous flakes of olive hornblende, and the other contained fractures of corroded feldspar and a scattering of sandstone fragments which were peppered with fine grains of magnetite.

Another exceptional sherd contained a scattering of sherd fragments and fine sand with numerous particles of augite. While it is not possible to recognize megascopically the character of temper in these sherds, they are generally much finer in texture than typical Glaze VI sherds from Pecos.

TEXTURE. Average grain size—0.22 mm.; range—0.16 to 0.30 mm. The largest rock fragment noted measured 2.0 mm. in diameter. The feldspar phenocrysts average 0.8 by 0.3 mm. Small crystals in the groundmass average 0.14 by 0.24 mm. The hornblende and augite crystals average 0.48 by 0.16 mm. Average grading: very fine—25.6%; fine—44.8%; medium—23.6%; coarse—5.2%; very coarse—0.4%. *Volume of temper:* average—31.2%; range—26.6 to 38.5%.

CLAY. Gray or brown in transmitted light, occasionally opaque. Isotropic,

rarely weakly birefringent. Refractive index between 1.550 and 1.564 in the majority of specimens.

Physical properties. *Color.* The paste color of the majority of sherds is relatively uniform. Oxidized margins are characteristic and are generally less than one-third the thickness of the vessel wall. The oxidized paste color varies from 11″i (Pecan Brown) to 7′i (Vinaceous-Rufous). Cores are usually Light to Pale Neutral Gray; 15″″″m (Blackish Mouse Gray) is less characteristic. Oxidized at 850° C. for 30 minutes—generally 13″ (Orange-Cinnamon); occasionally 11″ (Vinaceous-Tawny), 15″b (Pinkish Cinnamon) or 11″k (Rood's Brown) with margins of 9′k (Kaiser Brown). Refired to 1200° C.—7″i (Vinaceous-Russet) or 5″k (Prussian Red). *Hardness.* 3.5 to 4, usually under 4. Refired to 1200° C.—7+. *Modulus of Rupture.* Average—120 kg. per cu. cm.; range—104 to 147 kg. *Strength of Vessel Walls.* Average—32 kg. per 2.5 cm.; range—11 to 44 kg. *Apparent Porosity.* Average—25.9%; range—22.5% to 31.2%. Refired to 1200° C.—Average 15.2%; decrease—41.3%.

Slip. *Color. Light Slip.* Typically 17″′d to f (Vinaceous-Buff to Tilleul-Buff) and 13″′d to b (Light Vinaceous-Fawn to Vinaceous-Fawn) grayed. As a result of thinness and unevenness of application slips are usually streaked and modified by the underlying paste color which is 9″i to 11″i (Cacao Brown to Pecan Brown). The slip is often grayed as though stained with usage and then approaches 19″″e in color. Exceptional, more highly colored slips, are 13″′d to b. Oxidized by refining to 850° C. for 30 minutes—15″d to f (Light Pinkish Cinnamon to Pale Pinkish Cinnamon) grayed and 17″d to f (Pinkish Buff to Pale Pinkish Buff) grayed; 13″d (Light Vinaceous-Cinnamon) is exceptional. Refired to 1200° C.—21″′f (Pale Olive-Buff) or 21″′d (Olive-Buff) grayed. Often absorbed by the paste. *Reddish Slips.* 5′k (Brick Red), 9′i grayed, 9″i (Cacao Brown). Oxidized at 850° C. for 30 minutes—7″i (Vinaceous-Russet) and 11″ (Vinaceous-Tawny). *Hardness. Light Slip.* 3.5 to 4; occasionally as soft as 3 or as hard as 4.5. Refired to 1200° C.—blistered. *Reddish slip.* 4 to 4.5 occasionally. 5. *Thickness.* Varies from a film so thin as to be indistinguishable from the paste to 0.05 mm. in the thicker parts. *Finish and wear. Light slips.* A characteristic unevenness of slip is caused, partially at least, by indifferent smoothing of the vessel surface prior to slipping, the slip being thin on ridges and protuberances. It is generally entirely without luster and smoothing strokes are not visible but the thin streaks show that the surface was worked in a nearly horizontal direction. The exceptional, relatively even, coats show polishing strokes and have a medium luster. Crazing of the slip was not noted but in restricted areas shrinkage of the paste produces the effect of a crazed slip. It does not tend to peel or slough off but viewed microscopically the surface appears rough, pitted and scaly, this appearance being caused partially by wear, partially by careless smoothing. *Reddish slips* like the light slips are often ridged in surface but since there is little if any color contrast between slip and surface zone of the paste, the red slips are more even in appearance than the light ones. The red slips are slightly lustrous and faint horizontal polishing strokes can be seen. Fine crazing sometimes occurs but abrasion is exceptional. *Optical Properties.* Light slips, tan to light brown or dark brown and

nearly opaque in transmitted light, former group birefringent, latter isotropic; all cream colored in incident light. Refractive index varies from 1.549 to 1.567, the majority are between 1.553 and 1.564. There is no difference in refractive index between isotropic and birefringent pastes.

Glaze. *Composition.* Lead silica glass colored principally by a variable amount of iron. *Refractive Index.* Between 1.800 and 1.850 in the majority of specimens, greater than 1.850 in one-third and less than 1.800 in some, an exceptional one being 1.684. *Color.* The well vitrified glazes are typically olive brown. Colors are generally a step darker than Ridgway's *m* series from 15 to 21 (Brussels Brown to Dark Citrine) and the same range in the one primes (Prout's Brown to Olive-Citrine). The yellower members of the series preponderate. The glaze has frequently dissolved the slip exposing the gray paste which seen through the yellowish glass imparts to it a greenish hue. Colors, though in the majority of specimens are as dark or darker than *m*, are not uniform in intensity; 15k, 21k and 17′k, (Sudan Brown, Citrine and Dresden Brown) occur. More distinct greens include 21‴m (Dark Olive), 23‴k to i, 25‴k to m (Lincoln Green to Dusky Olive-Green) and 29‴i (Pois Green). Glazes altered by reduction are 19″m (Brownish Olive) and 23″m (Dark Greenish Olive). The dull imperfectly vitrified glazes are 13⁗i to m (Benzo Brown to Fuscous-Black), 17⁗ to 17⁗i (Drab to Hair Brown) and 21⁗m (Olivaceous Black [1]). Viewed microscopically the glass is pale brown or olive in color. *Texture and vitrification.* There are insufficient entire bowls in the collection to warrant conclusion as to the proportion of satisfactorily vitrified specimens and the sherds show only the defects which were common and the textures of the best vitrified pieces without indicating the proportion of successful vessels produced. The best vitrified specimens are highly lustrous, but blistering especially locally is common, and surfaces are roughened by inclusions. Occasional specimens are chipped and a peculiar etched appearance is not rare while encrusting appears to have been common. Crazing is characteristic, two-thirds of the sherds examined being crazed in at least the thicker, lighter parts, many over the entire surface. *Hardness.* The majority of specimens are 5.5, a few are 5, and none harder than 6 was found. *Solubility.* The majority of specimens are readily soluble in 1:1 hydrochloric acid, only rarely is one found which is only slightly attacked. *Thickness* varies from 0.05 to 0.43 mm. Typically thicker parts of the glaze vary from 0.14 to 0.29 mm. and the thinner from 0.05 to 0.08 mm. Variation in thickness on a single specimen may be as great as 0.37 mm., though frequently is only 0.05 mm. *Inclusions.* A large proportion of the glazes are clear and free from flocculent patches or spots of partially dissolved pigment, though these sometimes occur. A characteristic appearance is caused by the exposure of paste and coarse temper; the grains of feldspar often appearing opalescent and the black splinters of ferromagnesian mineral giving a speckled effect. Patches of partially dissolved slip are not uncommon especially near the margins of the glaze. Minute unbroken bubbles, usually microscopic in size, dispersed throughout the glaze are characteristic.

Firing. Calcite was found in two of the twenty-four sherds thin sectioned and six sherds from the same group were flaked by the action of lime.

Color of paste margins indicates an oxidizing atmosphere.

INTERPRETATION OF TECHNOLOGICAL DATA

Totally new ceramic practices and materials were introduced when Glaze replaced Black-on-white ware. The decoration of pottery with a true glaze is, of course, the most striking innovation, but body and slip clays, temper and firing methods also differ from those used in the preceding period. Definite proportions of ingredients and firing temperatures were necessary for the successful production of glaze, which, therefore, required greater skill than decoration with a plant extract. By firing ferruginous clay in an oxidizing atmosphere there was obtained a pleasing range of reds, buffs and creams, in marked contrast to the unrelieved monotony of Black-on-white ware grays. What brought about these discoveries? They are clearly not the outgrowth of experimentation with the materials known in the Black-on-white period. If glaze was introduced into Pecos through pueblos where the art had been mastered, how long did it take for Pecos potters to learn to make the ware and what were the sources of influences which led to its development?

The distinct classes of temper which occur in the various types throw some light on problems of origin and relationship. The earliest Rio Grande Glaze types, I Red and I Yellow, were tempered with crushed igneous rock, either basalt or fine-grained and porphyritic rock of intermediate composition. Toward the end of Glaze I times there appears at Pecos in minor proportions a type (tempered with either sand, siltstone or fine sandstone) having certain characteristics of Glaze I Red though technically inferior in practically every respect; the red slip is impermanent, the glaze imperfectly vitrified and the paste sandy and friable. The three succeeding types, Glazes II, III, and IV, are also tempered with siltstone or stream sand, with the exception of a few specimens which contain ground igneous rock similar to that found in Glaze I. Glaze V, the most distinctive and persistent of Pecos Glaze types, was evidently always tempered with stream sand or crushed siltstone, no example of igneous rock temper having been found. In Glaze VI, the last type of the series, however, igneous rock reappears, and sherd- or sand-tempered specimens are extremely rare. Several different kinds of igneous rock were used, but petrographic examination rarely discloses the mixture of the different varieties in a single specimen which would be expected had drift rock from washes or stream beds been gathered for temper. Although disintegrated rock would be most easily ground, the feldspars seldom show the degree of alteration characteristic of material from weathered outcrops.

The major geologic formations of north-central New Mexico have been mapped and described in sufficient detail to render it possible to ascertain within very definite limits the source of these various tempering materials.[1]

The siltstones, sandstones and sand all occur in the immediate vicinity of Pecos, but the nearest formations of the igneous rocks used are from twenty-five to thirty miles distant from the site. Basalt occurs in the series of volcanic cones which extend in a north-south line paralleling the Rio Grande and probably marking an old

[1] The principal formations are shown on the *Geologic Map of New Mexico* prepared by N. H. Darton, U.S. Geol. Survey, 1928.

fracture. The flows nearest Pecos are some forty miles due west, directly northwest of the Cerrillos Hills. Various types of basalt are found in the sherds; olivine is present in some, absent in others, and the relative size and development of feldspar and augite crystals vary. With more detailed field studies these characteristics may aid in locating more closely the source of materials. All the igneous rocks with the exception of the basalt are of intermediate composition and are to be found in only one locality in this general region; they form the chain of hills and low mountains on the west side of the Galisteo Basin and include South, San Pedro, and Ortiz Mountains south of Galisteo Creek and the Cerrillos Hills north of the creek. The geologic history and petrographic features of the Cerrillos Hills have been described by D. W. Johnson.[1] These hills are laccoliths which were formed at the close of the Cretaceous period. Erosion during the Tertiary era removed the sediments which originally covered them. The occurrence of different rocks, all of the same general class, prove that there were successive intrusions all, however, tapping the same magma.

These various rock series are described and located by Johnson, and although his nomenclature differs somewhat from present geologic usage, the petrographic descriptions based on microscopic analysis of over one hundred thin sections serve as a general guide in locating the source of rock temper in the Glaze types. Briefly reviewed, the main rock types are a hornblende-andesite series found in the eastern foothills and representing an earlier intrusion than the augite-andesite series which makes up the main part of the hills, including the larger peaks and many of the radiating dykes. An eruptive breccia, older than the laccolith and formed from explosive outbursts af some volcano near the shore line of the Cretaceous sea, occurs in the red sandstone east of the hills. Still older are the several interstrata sheets of mica andesite in the sediments west of the hills. The distribution of these rock series and the fact that more than one variety does not occur in a vessel suggests the possibility of definite location of sources of temper which will throw light upon the introduction of Glaze in this area when exhaustive field studies have been made. The temper of twenty-four Glaze I Red sherds obtained from general digging was found upon petrographic examination to include the greatest number of distinct varieties of rock. Approximately one-third of the sherds were tempered with very fine-textured diorite of extremely uniform character in all specimens. One-third of the sherds were tempered with porphyry, which varied from sherd to sherd in the relative proportion of groundmass, development of phenocrysts, and accessory minerals. The remaining third is a miscellaneous group, but most of the sherds contain some basalt, which, however, may be combined with potsherd. The temper of Glaze I Yellow is much more uniform. Diorite occurs in over two-thirds of the sherds and the majority of the remainder contain porphyry (basalt is exceptional). Porphyries preponderate in the rock-tempered specimens of later types. Geologic field work will be necessary to locate precisely all these varieties, but the eruptive breccia which outcrops near San Marcos pueblo has been definitely identified in Glaze VI sherds, while the diorite characteristic of the early types corresponds most closely to Johnson's "gabbro-porphyry" which occurs in some of the central peaks of the Cerrillos Hills.

[1] 1903.

In contrast to sherds from Pecos, Glaze specimens collected at the Galisteo sites are all tempered with igneous rock, the only exception being a very few sherds which are identical with Pecos Glaze V, a rare type in the Galisteo. These facts were established by microscopic examination of material from Nelson's excavations and of surface material from all the principal ruins of this area.

The clays of the rock- and sand-tempered types differ. Although the majority of the former and all of the latter are red-burning, there is a significant difference in refractoriness and the rock-tempered paste is consistently less refractory than the sand-tempered. Experiments with the various types of temper prove that the difference is of greater magnitude than would be caused by incipient fusion of the rock temper. In addition some of the rock-tempered specimens have been made from a buff-burning clay which is never found combined with local material. This buff paste is not uncommon in Galisteo Glazes and recalls the buff-burning clays of the Black-on-white type from the same region.

The occurrence of igneous rock temper in Pecos Glaze pottery must be explained by one of two theories; that is, either igneous rock, or the pottery containing it, was imported. It is tentatively assumed at the start that the art of glaze painting was not independently discovered at Pecos, for it is most improbable that such an important advance would have been made by a peripheral pueblo which had been an imitator rather than an initiator during earlier stages of Upper Rio Grande ceramic history. Moreover, available data on the relative age of Glaze sites lends no support to the idea that glaze paint was first used at Pecos. Stratigraphic evidence proves that Glaze ware was made in the Little Colorado region earlier than in the Rio Grande, for intrusive sherds of Little Colorado Glaze ware are found in Pecos refuse of the Black-on-white period antedating the first appearance of Rio Grande Glaze types. The most direct trade route from the Little Colorado would have entered the Rio Grande Valley in the neighborhood of Albuquerque. If knowledge of the technique as well as the pottery itself came from the Little Colorado, villages of the middle Rio Grande having the most direct and frequent contact would probably have been the first to make the ware, and the art would have spread up the Rio Grande Valley and across into the Galisteo Basin, eventually reaching Pecos. The theory of importation of raw material rests on the supposition that Pecos potters, having learned to make Glaze ware from Galisteo people living in the neighborhood of the igneous formation, at first followed their technique in every detail, even to the point of going thirty to forty miles to obtain the same kind of temper. This hypothesis does not explain the diversity of igneous rocks used, the total absence of igneous rock of local origin, such as the granites and amphibolites found as drift in the Arroyo del Pueblo and the association of igneous rock with foreign clays; nor is the assumption that Glaze ware was indigenous from the start consistent with the fine workmanship of early Glaze bowls as contrasted with the poor specimens that appeared later, the persistence of a small number of rock-tempered vessels, and the final predominance of a rock-tempered type.

The theory that all vessels containing igneous rock are intrusive rests on the probability that Glaze ware, although valued from the first, could not at once have been reproduced by people unfamiliar with the materials and methods. Moreover,

the Pueblos making it may have realized the advantage of keeping secret the source of the flux, for there certainly must have been more or less mystery about the shiny substance which was so totally different from the old, dull organic paint. If several generations passed before Pecos potters learned to make glaze no decorated pottery could have been produced locally during this time, since Biscuit, the only contemporaneous painted ware, has also been explained as intrusive. This interpretation of evidence has not hitherto been seriously considered because it assumes a volume of trade and degree of industrialization not previously demonstrated. Nevertheless, it is not at all unlikely that Pecos, lacking a local supply of the essential materials, should have bartered for the new ware instead of continuing to make the older and less attractive Black-on-white vessels. This explanation also most logically accounts for the character and sequence of Pecos Glaze types.

Glaze I Red appears at Pecos as a fully developed type; from the first, vessels are well made and the crudeness and imperfections which usually characterize the trials of beginners are not found. Neither is there a disproportionate number of failures among Glaze I Yellow specimens. The depth of the refuse in which these two types preponderate indicates that they had been made for several generations, and it is only toward the latter part of the period that an inferior imitation of Glaze I Red tempered with sand or siltstone occurs—specimens which have been classified as Local Glaze I Red. The defects of this variety of Glaze I are such as would result from inexperience with new materials and methods rather than from carelessness and indifference. A red slip was never used in the Black-on-white period at Pecos, although sherds of St. Johns Polychrome, a Black-on-red ware imported from the Little Colorado region, attest to the popularity of bright-colored vessels. Pecos potters evidently did not know that many ocher clays would burn to a pleasing red and selected instead a substance which contained a high percentage of hematite and insufficient clay to bind it upon firing; consequently, the slip rubbed off with usage and often caused the glaze to peel or chip. There are more examples of dull, imperfectly vitrified glaze on this type than on any other, and the frequent occurrence of calcite in the paste proves that firing temperatures were low. The potters evidently had not learned that temperatures which would harden Black-on-white ware were insufficient to flux a glaze.[1] But by Glaze II times the technique had been mastered, for Pecos pottery tempered with sand or siltstone is indistinguishable in surface features from pottery occurring in more centrally located sites.

With the opening of Glaze II, Pecos entered upon the period of its greatest ceramic independence, for from this time through Glaze IV only 6 to 8% of the sherds were tempered with igneous rock, and the climax of development came when Pecos potters broke away from the stylistic canons of their neighbors and produced a distinct local type, Glaze V, which seems to have continued in use longer than any

[1] The specimens of these types in Test XXI were checked microscopically. The sand or siltstone-tempered examples were absent from the two lowest cuts in which Glaze appears (Cuts 8 and 7) and make up from 2.5 to 3% of the total Glaze sherds in the two succeeding cuts. The presence of sherd temper and the high proportion of basalt in early as compared with late Glaze I suggested that at first vessels were obtained from the more distant Rio Grande Valley villages, but when the technique was fully established in the Galisteo Pueblos, Pecos traded mainly with the people of this area.

other.[1] The fact that with few exceptions the last type, Glaze VI, was tempered with igneous rock indicates that Pecos ceased to make Glaze ware sooner than neighboring communities, since this type, though in part contemporaneous with Glaze V, continued in use somewhat longer. Dr. Kidder, from his study of general occurrences and characteristics, has independently reached the conclusion that Glaze VI was intrusive at Pecos. Thus the entire history of Pecos Glaze is most logically explained by the theory that rock-tempered vessels are trade ware, and general archaeological data support this conclusion. We have therefore evidence of the relative length of time which elapsed after the introduction of Glaze before it was successfully imitated, and can study the development of local types without being confused by the large proportion of foreign specimens.

The indigenous types, Glazes II to V inclusive, afford the best opportunity of any ceramic group from Pecos for studying evidences of change or advance in technique. It may well be asked whether during this long period when Pecos was at the climax of its ceramic development, different clays, various kinds and proportions of temper or distinct firing methods were used, affecting hardness, density, and strength of the pottery, or whether a technique once found satisfactory was followed, with little change or effort toward improvement. The physical properties of the ware are surprisingly uniform throughout the period. The outer and inner zones of vessel walls were usually oxidized to a red-brown varying from 9 to 17 in hue, *i* to *b* in intensity, and ′ to ‴ in value, the majority being 11 to 15, unmodified to *i*, and ″. The cores are typically 15‴″i to 15‴″f. On refiring to 1200° C. these pastes all change to a deep red-brown, 7′k to 7″i. The hardness is invariably 3.5 to 4.5; and upon refiring to 1200° C. is increased only to 5 or 5.5. The strength of the vessel wall likewise indicates no significant change. The variation between types in average apparent porosity is only 3% and both minimums and maximums of types differ by 6%; upon refiring to 1200° C. all types exceed 15% in apparent porosity, which percentage is exceptional for red-burning clays of the Upper Rio Grande. The properties of the paste, therefore, do not record any consistent difference either in clay or firing treatment, the variations being only such as usually result from primitive method, and are no greater between types than within types.

Temper is variable in the indigenous types and there are slight indications of intentional change. The majority of specimens are tempered with ground or disintegrated siltstone or fine sandstone. This temper evidently came from more than one stratum, because cementing material and mineralogical composition differ. A large proportion of fine siltstone containing considerable biotite and ferruginous material characterizes Glaze III, while fragments with calcareous cement are common in Glaze V. Stream sand was occasionally used instead of siltstone, but the proportion of stream sand decreased steadily from Glaze II to Glaze IV, in which type it was not found. Sand temper reappears in a significant number of Glaze V specimens, and the proportion increases in the late examples of the type. When viewed megascopically Glaze IV gives the impression of being somewhat finer and Glaze V some-

[1] The percentage of occurrences of igneous rock in Glazes II to V was determined by microscopic examination of lots of from fifty to sixty sherds found in general digging.

what coarser in texture than the other types, but micrometric determinations reveal no important change in average grain size or in grading. Glaze V has a higher percentage of medium grained temper and its average and maximum grain size is also slightly higher than that of the others. But these differences are insignificant when compared with those existing between the sand-tempered and the rock-tempered types. Not only is the percentage of medium and coarse grains higher in the latter[1] but the fine grains are always in excess of the very fine, just the reverse of the condition which normally obtains in the sand or sandstone tempered pastes.

The fineness and uniformity of grain size of siltstone compared with that of stream sand may explain its use for temper. The material would not be difficult to crush, especially if partially disintegrated, and its superiority would quickly be recognized. It is possible, however, that Pecos potters were influenced in their selection of siltstone and sandstone by the custom of rock tempering practiced by their neighbors. They would, of course, distinguish between a tough dense igneous and a friable sedimentary rock, but if any superstition existed regarding the rock—that it imparted hardness or strength—the same reasoning might be applied to any consolidated material. This explanation is much less plausible, however, than the first. If the potters wished to use rock they would naturally select drift rock from the arroyo. The occasional occurrence of stream sand in most of the types which are predominantly tempered with siltstone suggests that there were always some potters who were careless about the texture of their paste. It also strengthens the assumption that the recognition of superiority in texture of material resulted in the characteristic Pecos custom of tempering with siltstone.

The slips of Glaze ware differ in color, texture, and hardness, the greatest contrast existing between the whitish or cream slips of Glazes II, III, and V and the warm tan, buff, or light orange slips of Glaze IV. The association of a distinct slip with a variation in rim form is particularly interesting and suggests considerable standardization in style. The study of clays of the Pecos region has failed to reveal the source of Glaze IV slip clays, and it is possible that they were obtained in trade or from a distance. This condition might explain the limited occurrence of the type. A very soft whitish slip was used occasionally throughout the period and resembles in properties the extremely refractory white-burning clay which occurs in a thin stratum near the hematite mine on Glorieta Mesa. This material may have been tried at different times by potters attracted by its color, but who would soon have learned that it was too soft to be suitable for pottery.

Glaze paint is not only the most characteristic feature of Glaze ware, but also its most interesting attribute, since it presents well defined problems of origin and diffusion. A true glaze is a glass formed by the combination of fusible bases with silica. The bases or fluxes may be divided into three classes: metallic oxides, as lead oxide; alkaline earths, as the oxide of calcium; and the alkalies, soda and potash. Silica can be supplied with the flux or if the flux is applied directly to the surface of

[1] The percentage of medium, coarse and very coarse grains combined is 17.6, 14.3, and 29.0 for Glaze I Red, I Yellow, and VI respectively as compared with a maximum of 9.2% (Glaze V) for the sand tempered types.

the unfired vessel, silica will be taken up from the clay. The fusing point and other properties of the glaze are modified by other compounds such as the alumina taken from the clay with the silica. Various colors are imparted by the oxides of certain metals, particularly iron, copper, and manganese. As glazes are often complex in composition, requiring given proportions of ingredients and having definite melting points, their production suggests some advance in the understanding of materials and better control of firing conditions.

The discovery of glaze marks a decided advance in ceramic technique. The Pueblos were the only American Indians known to have produced this substance. Pueblo glaze paint wares, therefore, offer an unusual opportunity to study the history of a fundamental ceramic achievement. Of particular interest are the factors which led to its discovery, the rapidity with which the knowledge of its production spread, and the modifications which it underwent.

The study of Pecos glaze paint presents two principal problems: How do the imported glazes compare with the local? Were there intentional changes, during the time when glaze was made at Pecos, in composition, mechanics of application, or control of firing? If there had been decided changes in the methods of producing glaze paint, some indication would be expected in the outward appearance of the glazes themselves. However, when a quantity of sherds of all the Pecos Glaze types is examined, one is first impressed by the great variability within each type, and the few consistent differences between types. There are many examples of failure throughout the series—glazes which are dull and rough because of blistering, or matte from thin application, or granular and lusterless from incomplete vitrification. In every type there are glazes both so thin that they are practically without relief, and so thick that they spread and flowed during firing. Color ranges from black to brown with rare olive greens and yellows, and peculiarities such as iridescence, occur sporadically. In other words, the glazes are of just the character that would be expected to result from an uncertain mixture of materials combined with poorly controlled firing. A few differences between types are noticeable, however, even upon casual examination. Glaze I Red is distinctive. As compared with subsequent types, the glaze is more often black and opaque. It is also thinner and had far less tendency to spread; it practically never ran, and consequently it was a better medium for decorative design than any of the later glazes. The glaze of late types (Glazes V and VI) was extremely thick, seldom held to a line, and often ran. It is useless for elaborate or carefully drawn design, and in the final decorative effect, the pattern was always subordinate to the vitreous luster of the paint. Glazes produced in the middle period do not appear intermediate in character between these two extremes, but rather show examples of each, though that of Glaze IV resembles that of Glaze I Red in its characteristically darker color, thinner application, and proportionately sharper lines. The glaze paint of Glaze I Yellow as compared with Glaze I Red is browner and spreads more often, while in Glazes II and III there is a confusing diversity in properties.

The characteristics of the glaze on entire bowls of the Pecos collection, and also on lots of representative sherds (60 to 75 of a type), were tabulated in order to establish the significant variations and bring out the differences which would be

shown in percentage of occurrence, since a high degree of uniformity could not be expected. Entire bowls are of particular advantage in the study of certain properties. It is obviously impossible, for example, to determine the ratio of successes to failures from fragments, for many of the entire bowls are smooth and glossy in one area and dull and rough from blistering and incomplete vitrification in another. Sherds from a group of such bowls might lead one to the conclusion that some of the vessels were well vitrified and others imperfect. The relative evenness of application, traces of brush strokes, degree of uniformity in color, indications of firing atmosphere are also best observed from entire material. Four hundred bowls in the Pecos collection, comprising 38 Glaze I Red, 25 Local Glaze I Red, and from 64 to 106 of each type from Glaze I Yellow through Glaze IV, were examined for these characteristics. Unfortunately, there are very few Glaze V bowls in the collection, because this type was made in the period following the Spanish Conquest when, influenced by the priests, the Indians no longer made mortuary offerings of pottery, which are the chief source of entire bowls from the site. The same condition holds for Glaze VI, which being a trade ware used for a relatively short period was even more rare than Glaze V. Percentages of occurrence in the last two types, therefore, are not significant and have not been recorded. Mortuary pottery is not necessarily representative. Dr. Kidder, indeed, has suggested that Pecos potters did not choose their best bowls for burial with the dead, but may indeed have picked the poorest. Such a conclusion can be established only by studying the characteristics of workmanship and not by observing surface alteration, because vessels buried with the dead are subject to different conditions than are sherds found in refuse. These conditions may not have been equally favorable to preservation. A dull gray or whitish incrustation is common on Glaze ware, often covering the glaze and not the slip. This coating is in part calcium carbonate deposited from soil water, but some of it is insoluble in hydrochloric acid. Since many of the glazes are dissolved by acid, it is probable that the dull deposit may in part, at least, be formed from the solution of the glaze by soil water after burial or discard. As mortuary bowls were in contact with the products of decomposition of the body, the glaze of these specimens may have been affected differently or more completely than that on sherds. Although the incrustation is much more common on the entire bowls than on the sherds, only further studies can prove whether this difference results from character of the soil or whether the defect developed with use of the vessel and the Indian selected these less attractive specimens for mortuary offerings. With these reservations in mind the properties of the glaze may be summed up as follows:

Color. The color of the glaze as it appears to the naked eye is exceedingly variable and depends upon a number of factors: the color and thickness of the glass, the color and amount of pigment in suspension, and, if the glaze is in part or wholly transparent, the color of the clay surface beneath. The appearance of the opaque glaze of Glaze I Red is affected by minute particles of pigment held in suspension, while in the transparent glazes of subsequent periods a distinct effect is produced by gray clay seen through the clear glass. The modifications produced by undercolor are best appreciated in specimens in which a light glaze has been used to outline a decorative motive in red paint; the dark brown of the glaze which has spread over

the paint contrasts with the pale yellow of that on the slip. Another interesting color difference may be noticed where the glaze has attacked and partially dissolved the slip clay, revealing the granular, gray paste underneath. In some cases the slip is entirely dissolved under the line of application of the glaze, but has not been attacked where the glaze has spread beyond the line. The extent to which the glaze color is changed by reaction with the surface clay naturally depends upon the composition and amount of clay taken into solution. Glazes which spread just before cooling had little time for reaction, and some clear red patches in glazes over ferruginous clay paint are explained by this fact. Other conditions produce variations in glaze color even on the same vessel. In glaze which flowed upon melting, the undissolved pigment often collected in patches, producing an uneven or mottled effect; in some instances the glaze spread without carrying pigment, forming lighter margins; in others it carried the pigment to the edges of the line, leaving the center clear. The color of the glaze is also affected by firing temperature and atmosphere; in areas subject to a reducing atmosphere a light brown glaze becomes dull olive or leaden in color. The color of glaze, particularly on entire bowls is, therefore, difficult to classify and describe. The various factors, in addition to the kind and quantity of pigment which influence color, must be recognized to avoid confusion.

Only a few generalizations regarding the color of Pecos glaze can be made. A sufficiently high percentage of granular pigment to produce a solid black is characteristic of Glaze I Red, common in Glaze IV, less frequent in Glazes II, III, and V, and rare in Glaze VI. With the exception of Glaze IV the series shows a rise in hue from orange-red to yellow. The exception may be explained by slip color, as Glaze IV is the only type after Glaze I Red that has a deeply colored surface. Many of the greenish browns and olives common in Glaze VI and found sporadically in transparent glazes of other types, particularly Glaze III, are due to the effect of exposed gray body clay showing through light yellow glaze, for certain yellows take on a decided greenish cast when grayed. True greens are very rare. Light colored glazes (lighter than *k* in intensity) are in the minority and are not found in Glaze I Red. The very few tints are in practically colorless glaze on light slip. The degree of vitrification influences the value of the color and imperfectly vitrified glazes are '''' to ''''' in value, while those which are well vitrified are unmodified or '. Blistered glaze is typically 13 to 17, *i* to *k* and '''' to '''''. In general, the color of the glaze as it appears to the unaided eye is modified by so many conditions that it cannot be considered a reliable means of identifying the pigment in the glaze.

Vitrification. It is as difficult to classify bowls by their vitrification as by their color, and the attempt is as likely to lead to confusion. A number of defects destroy the luster of the glaze: application so thin that the flux sinks into the clay and serves only to bind the pigment[1]; granular pigment and other mineral inclusions, as well as minute blisters which produce a finely pimpled surface; a honeycombing by small, close, broken bubbles; and finally, incomplete vitrification from underfiring. It is not unusual to find several of these defects in a single bowl, in part

[1] In experiments with simple glazes made by painting lead carbonate containing 5 to 10% of manganese oxide or ferric oxide on clay, thin lines were matte in appearance even when fired to temperatures (800° to 950° C.) which vitrified the glaze of thick lines.

of which the glaze will be smooth and glassy, while bowls with perfect vitrification of the entire glaze are exceedingly rare. It would be particularly interesting to be able to determine the proportion of failures, and whether improvement is reflected by an increase in the number of successful glazes as the period advances. Classification of specimens on the basis of quality of glaze must, however, be influenced by personal judgment because of the intergrading of textures. Nevertheless, the percentage of bowls in which the glaze was mainly smooth and lustrous and the frequency of occurrence of the various defects were recorded for each type. In Glazes I Yellow to IV the percentage of well vitrified glaze varies from 4 to 24, the highest proportion being found in Glaze I Yellow and the lowest in Local Glaze I Red, while Glazes III (18.6) and IV (15.0) show an improvement over Glaze II (5.0). The number judged successful in Glaze I Red was even higher than in Glaze I Yellow, but this is perhaps misleading because the glaze in the former, though vitrified and free from serious defects, is not as highly lustrous as the well vitrified glaze of subsequent periods because of the large amount of pigment held in suspension in the glaze which gives it a finely granular texture and semi-matte luster. The proportion of bowls which are blistered differs but slightly from Glaze I Yellow to Glaze IV, varying from 49 to 55%. In Glazes I Red and Local I Red, the percentage is distinctly lower (26 and 28% respectively). With one exception there is little difference between types in the proportion of glazes which are partly matte from thin application. They vary from 15 to 20% in all but Local Glaze I Red in which there is 36%. The fact that thin glazes occur in all the types up to V is partially due to the inherent difficulty of applying an even coat, and shows that it was never fully overcome. The percentage of sintered or incompletely vitrified glazes likewise does not show significant differences between types except in Local Glaze I Red (32% as compared to a range of 13 to 21% in other types). Had there been enough entire bowls of Glazes V and VI to add to the list, some differences in vitrification might have been shown in the late as compared with the early glazes. But from the specimens available for study, it appears that the proportion of well vitrified pieces was highest in the early imported glazes (Glaze I Red and Glaze I Yellow), lowest in the first glaze made at Pecos (Local Glaze I Red), and that after the technique became established from Glaze II through Glaze IV times there was a gradual improvement, though the principal defects persisted, showing that they were either never understood or were unavoidable with primitive methods.

Thickness. The Glaze types differ in thickness of application of the glaze paint; on Glaze I Red it is typically thin (0.03 to 0.08 mm.), on Glazes I Yellow to IV it attains somewhat greater thickness (maximum 0.14 to 0.20 mm.), while on Glazes V and VI it averages three to four times as thick (maximum 0.33 to 0.43 mm.) as on Glaze I Red. Occasionally drops 1.5 mm. or more in thickness are found on all types but are much more frequent on the late types. The application is even on over half the Glaze I Red bowls; the proportion decreases in the four succeeding types, varying from 25 to 40%, but shows no significant trend. Differences in thickness are noticeable between the beginning and end of brush strokes and particularly in large solid areas in imperfectly vitrified glazes, while narrow lines are often thinner than wide ones.

Brush strokes can be traced on many bowls and are more conspicuous in some types than in others, appearing on one-third of the I Red and I Yellow bowls, and on from one-fifth to one-quarter of the bowls of Glazes II to IV. A marked difference in width of line at the beginning and end of a stroke shows that the consistency of the glaze was such that it did not spread evenly. Strokes average 12 to 15 cm. long, and the line is often twice as wide at the beginning of the stroke as at the end in consequence of the spreading of the heavier part. This observation refers particularly to the framing and banding lines.

Spreading. The well vitrified glaze had a tendency to spread beyond the line of application, and when very thick ran. The glaze spread in 25% of the Glaze I Red bowls (though so slightly as to be hardly noticeable on most pieces) and in half of the Glaze I Yellow. The same proportion of spreading is found on Glazes II to IV, only as the glaze became thicker the spreading was more conspicuous and was, of course, particularly striking in the thick, late glazes. The percentage of bowls on which the glaze actually ran is small, 2 and 3% respectively in Glazes I Red and I Yellow and the drip is short; while the percentage is from 6 to 13 in Glazes II to IV, being highest in III. There were usually only a few exceptionally thick spots from which the glaze ran. The direction of flow is interesting as a mark of position of the bowls in firing. In some of the most conspicuous examples in Glazes V and VI, the glaze ran toward the rim, from which it has been inferred that the vessels were fired in inverted position. The Pecos bowls do not show uniformity in this respect: 2 out of 4 in Glaze II, 6 out of 14 in Glaze III, and 1 out of 6 in Glaze IV, ran toward the bottom of the bowl. It would seem that bowls were more often fired in an inverted position in the later period, but the number of examples is too small to give proof. The inverted position would generally be preferable to the upright because vessels are more stable when resting on a wide level orifice than on an uneven, convex base. In stacking vessels for firing, however, it might often have been more convenient to place some on edge or upright. Spreading and running of glaze are caused by several conditions, including thickness and amount of material, composition and viscosity of the glaze and firing temperature.

Crazing is rarely conspicuous in the early glaze and sherds were examined microscopically in order to learn the frequency of occurrence. Eleven per cent of Glaze I Red glaze is crazed, at least in thicker and lighter parts, and in Glazes I Yellow to IV, from 20 to 30% showed some crazing, the tendency being more common not only in the thicker glaze but also in that containing least granular pigment. The occurrence of crazing in Glaze IV clearly shows the relation of crazing to color and amount of granular pigment, for 13% of the dark, as compared with 60% of the light-colored, glazes were crazed, the average for the type being 28%. Pigment in suspension evidently counteracts the tendency of the glass to contract. The relation of thickness to crazing is illustrated by frequency of this defect in late types as compared with early. Glazes V and VI show 68 and 75% of crazing respectively. Glaze VI is the only type in the series in which crazing is usually clearly visible to the unaided eye.

The craze is very fine, spaces between lines averaging between 1 mm. and 0.5 mm. and spaces are irregular in size and shape. There are few long continuous

cracks, fractures are smooth, of approximately equal width and end in other cracks (fig. 308, *e*, *f*).[1]

HARDNESS of the glaze as determined by Mohs' scale varies from 4.5 to 7, but the majority of specimens fall between 5.5 and 6; the early glazes averaging harder than the later.

SOLUBILITY. Some glazes are readily attacked by hydrochloric acid and since there is a difference in solubility, types were compared by using a drop of 1:1 hydrochloric acid on ten specimens of each and noting the rate and extent of reaction. The glaze on the majority of Glazes I Red and I Yellow sherds was found to be only slowly attacked by the acid; while most of that on Glazes II to IV is readily soluble, and high solubility is even more general in Glazes V and VI.

PECULIARITIES OF THE GLAZE. *Beading* is almost limited to Glaze I Red. Whether this results from a property of the slip or of the glaze which affects its surface tension is yet to be determined. Beading occurs in 23% of the Glaze I Red bowls of the Pecos collection. Half that proportion was found in I Yellow bowls, and 4 to 5% of bowls of Glazes II to IV show in some parts a slight gathering, but in none of these is the tendency so pronounced or general or of quite the same character as in Glaze I Red, and a casual examination would lead to the conclusion that the characteristic is peculiar to this type.[2]

Pitting. An occasional specimen is found in all types except Glaze I Red in which a few small depressions averaging 1 mm. in diameter and 0.5 to 1.0 mm. in depth have been formed. They are always surrounded by a circle of glaze (2 to 8 mm. in diameter) which is either yellow or green and paler than the main body of the glaze. Frequently a trickle of this light glaze flowed over the slip for several inches, leaving a trace so thin that it is dull, and often cannot be seen except in certain lights. Occasionally these rivulets have reached the rim of the bowl and the drop of material collected there has left a characteristic depression surrounded with the circle of light-colored glaze. The obvious explanation of pitting is that some impurity occurred either in the clay or glaze which fused at or below the vitrification temperature of the glaze, forming a less viscous melt than the main glaze. The percentage of lead, determined by refractive index of the glass, is lower in the circles than in the glaze proper.[3]

[1] Character of the crazing is described by March's "Semi-crystalline" (1934, p. 41), but does not resemble his illustration of the type.

[2] Since the above was written a gathered or patchy glaze has been produced experimentally. Insufficient binder was used in the glaze mixture and consequently upon drying sections of it pulled away from the vessel surface. When fired those parts of a line not in contact with the clay flowed into areas which were adhering, thus producing irregular beads or ridges. Although the appearance is similar to that found on some of the Glazes subsequent to Glaze I Red it is less fine and regular than the characteristic beading of Glaze I Red.

[3] Attempts were made to reproduce this effect by introducing particles of various fluxes which might have occurred with the ore or in the clay. Cerussite, galena, wulfenite, stibnite, calcite and alkali were used with simple glazes made of lead carbonate with 10 and 15% of manganese oxide, supplied in the form of the dioxide. The inclusions were both mixed with the glaze and "planted" in the clay and covered with glaze. In all cases there was more complete vitrification around the inclusions, but in no instance were the characteristic circles formed.

It is thus seen that the characteristics of the glazes reflect the uncertainty of primitive methods and at the same time show noticeable chronological changes in color, thickness, hardness and solubility. In order to understand the causes of failure, the extent of accidental variations and the significance of consistent differences, it is necessary first to determine the chemical composition of the glaze by qualitative and quantitative analysis. The measurement of refractive indices also gives important evidence of composition. Physical characteristics—color of the glass, amount, grain size and form of granular pigment, presence and characteristics of mineral inclusions, gas bubbles and crazing, devitrification or crystallization of the glaze, and its thickness, relief, and relation to the vessel surface—should be checked microscopically. Finally, thermal experiments and synthetic tests, duplicating the conditions under which the Indians worked, are necessary to determine the firing properties of the raw materials which were available to them. A chemical analysis cannot be expected to show the composition of the material originally applied since, during firing, compounds are broken down and new combinations formed. The analysis of a lead glaze will for example, show the ratio of lead to silica, but not the source of either; the lead may have been derived from a sulphide, carbonate, sulphate or oxide and the silica may have come from the clay of the vessel or have been added with the lead. Questions regarding the original compounds, if answerable, will have to be answered indirectly. The principal facts learned from chemical analysis are the percentage of lead in the glaze, the ratio of alumina to silica, the possible presence of additional fluxes such as alkali or calcium, the kind and quantity of pigments and the presence of impurities which might furnish a clue to source of the fluxing materials. Results of chemical analysis also form the basis for synthetic tests. The chief obstacle in making quantitative analyses is the difficulty of obtaining a sufficiently large sample of the glaze unmixed with clay. If a sample of glaze containing some clay from the vessel surface is analyzed, and also the surface clay alone, the true composition of the glaze can be calculated from a comparison of the two analyses. But the procedure is not as simple as it appears, for the clay included with the glaze may be either slip clay or an uncertain mixture of slip and body clay and the problem of obtaining for analysis a sample of a very thin slip is almost as great as that of removing the glaze. Dissolving the glaze does not eliminate the danger of introducing slip, and the use of a steel instrument is out of the question when iron determinations are to be made. In the present investigation of the Pecos glazes, samples were obtained by scraping the surface with the sharp edge of a carborundum crystal, the manipulation being watched with the binocular microscope to avoid cutting into the paste. Although the process is slow, it is not difficult to avoid including paste when there is contrast in glaze and body color, but if they are the same, great caution must be exercised to avoid scraping into the paste unwittingly. The carborundum (silicon carbide) crystal is considerably harder than the glaze but flakes easily and if chips fall into the sample they will cause an error in the silica determination. For qualitative analysis, methods requiring only minute quantities of material, such as microchemical and spectrographic analysis, are especially valuable.

It has not been possible at this time to obtain all the analyses necessary fully

to describe Pecos glazes, but spectrographic analyses were made of five glaze samples which included four types—Glazes I Red, V and VI and Heshotauthla Polychrome. In addition a quantitative analysis was made of the Glaze I Red material.[1] These analyses show the possibilities of the methods and serve as a guide in outlining problems for future investigation.

All the spectrographic analyses were carried out under the same conditions and the strength of spectra of various elements can, therefore, be compared in the several samples. The lead spectrum is so strong in all the spectrograms that it suppresses the spectra of other elements and consequently quantitative estimates cannot be made.[2] A number of interesting differences are brought out, however, and may be significant if further analyses prove them to be constant. The sample from Glaze I Red—a blistered, opaque, black glaze, 6 in hardness and slightly soluble—has a strong spectrum for manganese as well as lead; copper is present, but iron and alumina are suppressed by the lead. The Heshotauthla Polychrome was analyzed for comparison with Glaze I Red since, though both are intrusive, the former came from a more distant source, paste and decoration indicating Little Colorado origin. This—a green, 23″k, glaze, 4.5 in hardness and slightly soluble—has strong lead and copper spectra, both being stronger than in Glaze I Red; manganese if present is only so in slight amount and the titanium lines seen in Glaze I Red are absent; zinc occurs in both types, but is weaker in the Heshotauthla Polychrome. If alumina is present in the latter, it is suppressed by a relatively large amount of lead. One would infer that this is essentially a lead glass relatively free from alumina.

The sample from Glaze V—a well vitrified, iridescent brown, 9m and 15k glaze, 5+ in hardness and very soluble—has a stronger lead spectrum than the sample of Glaze I Red, while the aluminum spectrum is much stronger than in the latter. Iron is well represented and manganese seems to be as strong as in Glaze I Red. The titanium spectrum is also strong. Material from two Glaze VI sherds, No. 764—a well vitrified, olive, 19m and 21m, glaze, 5 in hardness and very soluble—and No. 775—a brown, 15m and darker, glaze, 6 in hardness and moderately soluble—were analyzed for evidence of the normal variation in composition existing within a type as compared with that between types. The lead spectrum is stronger and the aluminum weaker in No. 764 than in No. 775. In the former, copper is found but the diagnostic lines are faint; in the latter copper is absent. In both, manganese, if present, is present in very small amount, no more than is found in any clay material. Iron is suppressed by lead. Silver is present in both and also common to all other glazes tested, though stronger in Glaze VI (No. 775) than in Glaze I Red. Sodium lines are also considerably stronger in this specimen of Glaze VI, than in Glaze I Red. Molybdenum is present in Glazes V and VI, absent in Glaze I Red.

[1] Both the spectrographic and chemical analyses were made through the courtesy of Dr. E. G. Zies, Geophysical Laboratory, Carnegie Institution of Washington. Dr. Zies' quantitative analysis of ten milligrams of material sets a high standard for future work, and he has also aided the study materially by his many helpful suggestions and general clarification of problems.

[2] The suppression of certain spectra by the dominant element could be avoided by a preliminary separation of the sample. Quantitative estimates could then be made which might be sufficiently accurate for comparison of the glazes, since slight variations in composition are rarely significant.

Results of the approximate quantitative analysis of Glaze I Red (same specimen as analyzed spectrographically) are as follows:

Weight of sample 0.0106 grams

Element	*Weight*	*Per cent*
SiO_2	0.0028	26
Al_2O_3	0.0007	7
Fe_2O_3	0.0004	4
PbO	0.0038	36
CuO	0.0003	3
MnO	0.0014	13
Na_2O	0.0011	10
	0.0105	99

The manganese sulphate obtained in the course of the analysis was tested microchemically and it was found that zinc and copper were present. The manganese was weighed as sulphate and checked calorimetrically. Copper, tested microchemically, was free from lead. Alkali sulphate was tested with potassium periodate for manganese and none was found. A test was made for calcium but it was not present in determinable amount.[1]

The spectrograms showed a difference between early and late glazes in percentage of lead, which difference raises the question whether the late glazes are consistently higher in lead content than the early ones. Fortunately the percentage of lead can be determined from the refractive index of the glass, since there is a constant relation between refractive index and amount of lead in the lead silicate glasses. The occurrence in the glaze of such substances as alkalies and alumina does not affect the determination, since their refractive indices approach that of silica. Titanium is the principal element which, occurring in quantity, would vitiate the results of this method of determining the percentage of lead.[2] The refractive indices of ten glazes from each of the six types, representing the range in color and thickness, were determined. The variation in percentage of lead in these specimens was

[1] The percentage of lead reported in this analysis is lower than that calculated from the refractive index of the glass, even when a correction is made for the granular material included in the chemical analysis and not in the optical measurement. Dr. Zies' analysis was made on a sample which the writer obtained by scraping the surface of the glaze with a carborundum crystal and it is probable that the sample was contaminated by a few particles of carborundum. The inclusion of carborundum would introduce an error in the silica determination; the silica reported would be high and the other element correspondingly low but the ratio of lead to pigments and to alkali would be unaffected.

[2] For a description of methods of determining high refractive indices see:

Merwin, 1913.

Larsen, 1921, pp. 16-20.

For data on refractive index of analyzed flint glasses see:

Wright, 1921, pp. 60-61.

Unpublished tables of Dr. Merwin's, giving indices of specially prepared glasses, were also used in the present study.

not great, none having less than 60%, and very few more than 80%, the majority falling between 65 and 75%. Nevertheless, the early glazes are uniformly lower in lead content than the late ones, while intermediate types show greater variation with examples covering the entire range. There are often two phases of glass in the same specimen, occurring in zones, or as veinlets and droplets, one within the other. The difference in amount of lead in these has not been found to be greater than 5% and seldom more than 3%. The glaze of I Red contains between 63 and 72% lead (refractive indices between 1.701 and 1.800), and in the majority of specimens the percentage of lead approximates 66.[1] An exceptional specimen, a very well vitrified brown glaze, contained over 72% lead. The lead content of samples from Glaze I Yellow is also less than 72% lead, though two specimens were found in which it approaches 72%. Two-thirds of the Glaze II samples contained between 72 and 77% (refractive index between 1.800 and 1.850) and one-third less than 72%. Glaze III is relatively uniform, the majority of glazes having two phases, one slightly more than, the other slightly less than 72%. Glaze IV samples are evenly divided, half containing between 72 and 77% and half less than 72%. In this respect it does not resemble Glaze I Red as closely as would be expected from its appearance. Glaze V, in contrast to previous types, showed few examples with lead content lower than 72% and in one-third of the samples the percentage of lead was above 77%, an exceptional sample reaching 79% (refractive index—1.890). Glaze VI was much more variable, one-quarter of the specimens containing less than 72% and one-third more than 77%, the remainder being intermediate in composition. The amount of lead in Glaze VI averages, therefore, higher than in any previous type except Glaze V.

The difference in refractive index and proportion of lead in the early as compared with the late glazes brings up an interesting question. Was there an actual difference, intentional or unintentional, in the composition of the material applied, or is the difference explained entirely by the greater thickness of application on the late Glazes? The simplest way for the Indian potter to make a lead glaze was to paint finely ground lead ore on the surface of the unfired clay vessel. The lead oxide formed upon oxidation of the ore would, if free from other substances, melt at 888° C. and react with the clay. It has been found by experiment, using the same rate of heating and the temperatures obtaining in primitive, direct firing, that with either galena (lead sulphide) or cerussite (lead carbonate) some glass is formed at 900° C., but with a thick coat complete vitrification does not occur below 950° C. The refractive index of such a glaze naturally depends upon the temperature and length of firing, as the longer the melted glass is in contact with the clay surface the more silica and alumina are taken into solution. However, glazes formed in this way, both with lead ore alone and with the percentage of pigment found in Glaze I Red, have indices showing less than 72% of lead. Glazes with the thickness and relief of the late

[1] The refractive indices are measured on small fragments of relatively clear glaze and estimates of the percentage of lead based on these determinations refer to the composition of the glass only. The chemical analysis is made on a composite sample containing pigment and other inclusions which are held in suspension in the glass. Unless the glass is perfectly clear therefore a lower percentage of lead is reported from a chemical analysis than is indicated by the optical method.

types were not obtained experimentally with lead ore alone, for when the material was heavily applied and well vitrified, it spread, leaving the original line thin or even depressed from solution of the paste beneath. On the other hand, when an equivalent weight of silica was added to the lead ore (77.8% of lead, a mixture which fuses at 770° C.) well vitrified glaze was formed at 800° C. This does not spread as does glaze from lead ore alone. The refractive index of the lead-silica glass fired to 800° C. indicates approximately 77% of lead, but when the mixture is fired to 900° C. and sampled where the slip has been dissolved the percentage of lead is slightly over 72%.

If the Indian added some material, such as very fine sand or clay, which furnished silica, undissolved remnants of this less fusible substance might sometimes be detected in the glass. Microscopic examination of the glazes does in fact reveal several types of inclusions in addition to pigment. Patches of very fine cloudy material, gray or light reddish in reflected light, suggest clay which has not been taken into solution. A scattering of quartz and feldspar particles (0.05 to 0.08 mm. in diameter) appears in some glazes, often producing a fine, granular appearance. In many of these specimens inclusions in the paste are exposed by the solution of surface clay, but in certain instances mineral grains clearly occurred in the glass. One glaze contained flakes of muscovite as well as quartz and feldspar. These minerals may, of course, have been of accidental occurrence.

Another condition which might explain the variation in percentage of lead is the difference in thickness of the glaze, for the thinner coat takes up proportionately more clay. If this were a principal factor, one would expect a close correlation between thickness and refractive index, which was not found. It is not at all impossible that the Pueblo Indians discovered the advantage of adding clay or very fine sand to their lead ore, but if they did, it is surprising that the proportions of material should have been kept sufficiently constant to give the slight variation found in amount of lead. Probably the only conclusive answer to the question will come from the analysis of glaze material from imperfectly fired bowls in which the glaze has not fluxed or reacted with the clay. A few examples of this kind are found in the Pecos collection, on some of which the material is so soft that it can be rubbed with the finger. Refiring a sample would show whether the material is comparable with that on typical specimens or whether it was some unusual mixture. In future excavations, special care should be exercised to preserve all examples of unfused glaze paint.

The quantitative analysis of the sample from Glaze I Red showed a comparatively high percentage of alkali. Alkali reduces the fusion point of a lead glass, and it has also been found by experiment that if alkali is added to the ground lead ore and pigment the consistency and spreading quality of the mixture are very much improved. It is of interest to know, therefore, whether the alkali in this glaze was added intentionally by the potter or whether it occurred naturally in the materials used. A certain amount of alkali would be derived from clay, and since the silica-alumina ratio (4.0) of the glaze, when corrected for included carborundum, approximates that of sedimentary clays of the region,[1] it may be assumed that these ele-

[1] Unpublished analyses by F. G. Hill, Colorado School of Mines, show silica-alumina ratios of 3.9 and 3.8 for non-refractory, red-burning clays from Santa Clara and San Ildefonso.

ments are a measure of the clay taken up by the glaze or mixed by the potter with the ore. The amount of alkali in clays is variable, from a trace to 9% in brick clays, Ries reports,[1] and the highest found in local clays analyzed is 3.3%. If the alkali in the clay united with the glaze were as high as 9%, then 0.0004 grams of the alkali in the sample would have been derived from the clay, leaving 0.0007 grams which must have come from some other source. Additional alkali would have been introduced if some binder were used with the glaze mixture, a vegetable extract such as the *guaco* paint of modern Pueblo potters, for example. The Pecos potters were already familiar with a vegetable paint and may have found it advantageous to mix the glaze material with some sticky juice to prevent its rubbing before firing. It has been found by experiment that 15% of *guaco* is ample to give good spreading quality and bind a glaze and that 50% is excessive as the lead is so reduced that it does not flux well and the mixture, even though thick, remains matte up to a temperature of 1000° C. Assuming that 20% of *guaco* was used and that Mr. Hawley's partial analysis of *guaco* ash showing 9% alkali is representative,[2] then 0.0001 grams of alkali would have come from this source. Alkaline water, if used, would not contribute as much as the *guaco* and these sources, therefore, account for less than half of the alkali found in the sample. Whether the Indian had learned the advantage of adding alkali (an extract from wood ashes, for example), or whether it was introduced unintentionally with the pigment or from some other source which has been overlooked, is a problem for future investigation. That this specimen of Glaze I Red is not unique in respect to the alkali content of the glaze is shown by the strong sodium spectrum in one of the samples from Glaze VI.

The absence of calcium in the analyzed sample of Glaze I Red is noteworthy, since calcium is a common constituent of many clays, and particles of calcite and marl sometimes occur in the paste of Glaze sherds.

Next to the question of fluxes, the kind and amount of pigment in the glaze is of particular interest. The quantitative analysis shows a high percentage of manganese, a trace of copper, and no more iron than might have been derived from a ferruginous clay, such as the red slip upon which the glaze was applied. Minute black inclusions are seen in thin sections of this glaze and, since the pigment is largely manganese, these are undoubtedly the manganese mineral and the cause of the opacity and jet black color on the glaze. These inclusions are non-magnetic, nearly uniform in size and too small to identify microscopically, averaging 0.003 mm. in diameter. They are angular in shape and, therefore, may have either crystallized from the glaze or been unattacked by it. They are very numerous in all samples of Glaze I Red examined, often practically concealing the glass and giving it the appearance of a mineral paint (fig. 308, *a*). The same characteristic inclusions are present in the glaze of subsequent types but become less numerous as the period advances. They often form scattered flocculent patches or collect near the surface of the glaze (fig. 308, *b*). Many examples of Glazes V and VI and also a small percentage of Glazes II to IV contain no undissolved pigment. The extent of solution of particles of pigment can often be observed with a 15-power hand lens. Patches of

[1] 1927, p. 141. [2] 1929, p. 739.

the pigment just described are sharply defined against the clear glaze (fig. 308, *f*), while other inclusions found more often in the later types are surrounded by dark rings resulting from partial solution.

Experiments were made to determine how much pigment would be dissolved in a simple glaze of lead carbonate applied on the raw clay. Glaze with 10% of manganese dioxide or ferric oxide had conspicuous patches of granular material when well vitrified (fired to 900° and 950° C.). Minute crystals of hematite formed in the glaze containing ferric oxide. When the pigment was reduced to 5%, manganese, iron and also copper oxide were completely dissolved. When the pigments (MnO, Fe_2O_3 and CuO) and lead (PbO) in the analyzed sample of Glaze I Red are calculated as 100% (as was done in these experiments) the pigment is 35% of the mixture. Three glaze mixtures were made on the basis of the quantitative analysis, using in each case the same ratios found in the sample; one was made with lead and manganese only, a second with alkali combined with these, and a third with clay added to supply the approximate proportion of silica and alumina to the pigment and fluxes. These samples were brought to temperature in thirty minutes and held for five minutes. At 800° C. all three mixtures were dull and could be rubbed easily; at 900° C. there was sufficient fusion to bind the pigment but even at 1000° C. they were less lustrous than the glaze on the average Glaze I Red sherd. The refractive indices of the glaze of all three samples fired at 900° C. was within the range of that from Glaze I Red, but the samples fired at 1000° C. had lower indices.

The spectrographic analyses bring out what may be an important difference in pigment between the earliest and latest glazes in the series, for the weak manganese spectrum in the two samples from Glaze VI sherds shows that the amount present is insignificant. The Glaze V sample, on the contrary, had as strong a manganese spectrum as that of Glaze I Red. In order to learn whether the Glaze VI sherds were representative, glaze from ten other sherds of that type were tested microchemically for manganese. These glazes covered the color range, and in all but two, manganese was either absent or the amount present was too slight to be significant. The two exceptional samples gave moderately strong tests.

The Pecos glazes when viewed microscopically by transmitted light show interesting differences in color of the glass. Glasses from Glaze I Red are predominately green, occasionally very bright, rarely light brown or nearly colorless; from Glaze I Yellow they are characteristically light brown, and from Glazes II to VI, light brown, yellow brown, pale olive and only rarely green. The color of the glass is determined by the pigment taken into solution and also, to a certain extent, by firing atmosphere and temperature. The intensity of color varies with the thickness of the particular glass fragment examined as well as with the quantity of pigment, but color can be compared in sections of standard thickness. The effect of manganese dioxide, ferric oxide and copper oxide was compared in glazes made of lead carbonate and pigment, painted on raw clay, and fired in an atmosphere and at a rate of heat increase comparable with the best conditions obtaining in primitive firing to a temperature of 900° C. Under these conditions yellow was imparted by ferric oxide, light brown by manganese dioxide, and green by copper oxide. The color of some pigments depends upon degree of oxidation which is influenced by firing conditions; green is produced

by the reduction of ferric oxide, for example. One particularly interesting illustration of reduction was found in a specimen of Glaze V which had two distinct color zones, the outer yellow and the inner dark green (fig. 308, *c*). The large amount of green in Glaze I Red suggests that the copper mineral or ferrous oxide was more soluble in the glass than the manganese mineral. The light brown of Glaze I Yellow is similar in hue to glass colored by manganese.

Conclusions regarding changes in either composition or source of pigment (whether included with the lead or added by the potter) would be premature at this time. But chemical analysis and microscopic examination have shown that there is much more to be learned than is summed up in the statement that these glazes are colored by manganese and iron with a small amount of copper.

It has been suggested that traces of elements associated with lead might serve as guides in locating the outcrops from which the material for glaze was obtained. The spectrograms showed traces of silver, zinc and molybdenum, all of which probably occurred with the lead. Silver and zinc are not significant since they are commonly associated with lead in deposits of this area. Molybdenum minerals are not common, however, and this element is more promising. There are three principal localities in the area where lead deposits occur, Terrero in the Pecos Canyon, the Cerrillos Hills, and the San Pedro Mountains. It is improbable that the Terrero deposits were known to the Pecos Indians, for there were no surface outcrops. In the Cerrillos Hills some twenty-five miles by airline west from Pecos, there are numerous veins, several of which are within a few miles of prehistoric turquoise mines. The principal lead-bearing vein in the San Pedro Mountains, the Lincoln Lucky Mine near the town of San Pedro, is approximately thirty-seven miles in an airline from Pecos. Trails used by the Indians would have added five to ten miles to the distance of these localities from Pecos. Judging from early reports, the outcrop at the site of the present Lincoln Lucky Mine was one of the most conspicuous, the weathered surface ores consisting of cerussite, manganese ores and limonite.[1] Unfortunately, prospecting and mining have destroyed whatever evidence may have existed of aboriginal workings of these outcrops and the character of the surface ores as well, and we have only brief descriptions from early reconnaissance at our command. A molybdenum mineral, wulfenite, has been reported from one of the mines in the Cerrillos district.[2] The occurrence of molybdenum in the three samples from late Glazes and its absence in the early is particularly interesting, and though it should prove impossible to locate particular veins or even the localities from which lead ore was obtained, the presence of an element such as molybdenum in all glazes of one period and its absence in those of another would afford interesting evidence of a change in source of material.

The possibility that some organic binder such as *guaco* was used with the flux has been mentioned. The probability is better appreciated after attempting to apply glaze without a binder, for the moment the brush touches the dry clay, water is drawn from the mixture, which piles up at the beginning of the stroke leaving little

[1] Lindgren, Graton, and Gordon, 1910, p. 172.
[2] Lindgren, Graton, and Gordon, 1910. p. 57.

material at the end. Then, too, the glaze does not adhere and will not only brush off easily, but if thick, drops off when the vessel is jarred. Although brush strokes are clearly marked on some of the bowls of the Pecos collection, there are many in which the strokes cannot be traced, especially in the thick late glazes. In the four hundred bowls of the collection, three were found on which the glaze material had been rubbed with the finger before firing but none from which patches had fallen as result of jarring. It seems highly probable therefore that some binder was used. It has been shown experimentally that when *guaco* is added to glaze, blistering occurs upon firing to approximately 800° C. Fine broken blisters are a characteristic defect of Pecos glazes. When the glaze is carried to 900° C., or 950° C., the gases escape and the glaze flows to a smooth surface so that mixtures with and without *guaco* cannot be distinguished at these temperatures. Although gases are given off from other substances in the glaze during firing, it seems probable that organic binder and low firing were important causes of blistering of Pecos glazes.

Firing temperatures and the possibility of improvement in firing methods during the Glaze period are of particular interest, since the successful use of glaze requires better control of firing conditions than is necessary in making matte paint wares. The temperature at which the glaze softens and the melting point of glasses that duplicate the composition of analyzed glazes, as well as the presence of calcite and flaking caused by the hydration of calcined carbonate of lime in the paste, are clues to firing temperatures. Sharp rims of broken bubbles are particularly useful for determining the softening point of the glazes. Thin flakes of glazes of all types show little change at 800° C., their edges become rounded at 850° C., and they flow into drops at 900° C. No decided difference has been found in the softening point of glazes of different periods. The fact that some glazes originally smooth and glassy become dull and blistered when refired to 850° C. also sets a definite upper limit for the firing temperature of these specimens. There are relatively few entire vessels which are flaked by the action of lime, the percentage being from 4 to 7 for the types from I Red to IV, exclusive of Local I Red in which the defect was not found. Among the sherds examined the percentage flaked by the hydration of lime was considerably higher (20 to 25%) for the intrusive than for the local types (0 to 4%)[1] This fact does not necessarily indicate higher firing of the intrusive glazes, for calcite and limestone may have occurred more frequently with the igneous rock than in the siltstone temper. The only conclusion justified is that from a fifth to a fourth of the intrusive glazes are known to have been fired to or above the temperature which decomposes calcium carbonate. Calcite was observed in thin section of some pastes and as an average of twenty-five representative sherds of each type was sectioned the percentage occurrence of calcite in these specimens has been calculated: Glaze I Red—4%; Glaze I Yellow—absent; Local Glaze I Red—37%; Glazes II to IV—absent, Glaze V—32%, Glaze VI—8.3%. As the temper of the local glazes is similar in composition, it would appear that Local Glaze I Red and Glaze V were less often fired to the temperatures which decompose calcium carbonate than the other local Glazes, but the proportion of flaked sherds in Glazes II to IV does not substantiate

[1] For a discussion of the significance of calcium carbonate as a thermal indicator see p. 426.

this conclusion and there may actually have been a difference in the frequency of occurrence of calcite in these local glazes. It is at least known that approximately a third of Local Glaze I and Glaze V specimens were fired at low temperatures and flaking has not been noted in either of these types. In the types tempered with igneous rock the percentage known to have been fired in the low range is small and the differences between Glazes I and VI may or may not be significant.

Indication of crude firing methods can be observed on most of the bowls. Areas subject to reducing conditions which have produced "smoke clouds" are found on from 80 to 90% of bowl exteriors, and from 14 to 27% of the bowls have reduced areas on the interior. Perfectly oxidized vessels are very exceptional. In the majority of cases the glaze is defective in reduced areas. The fact that some glazes under "smoke clouds" appear unaffected may possibly be explained as the result of reducing conditions obtaining only in the latter part of firing and after the glaze had vitrified. Another proof of simple methods and direct contact of pottery and fuel is found in the rough, granular surface of glaze on some bowl exteriors, particularly near the shoulder of the vessel. This roughness is caused in many cases by ash from the fuel falling upon the bowls and sticking to the soft, viscous glaze. Some patches examined microscopically show the structure of wood fiber still preserved in the ash.

Before the art of making glaze was lost, the Pueblos had acquired livestock from the Spaniards, and it is possible therefore that the change from wood to dung fuel was made while Glaze was still the principal decorated ware. While dung has certain advantages over wood for firing pottery, the difference is not so much in temperature range as in amount of radiated heat, and no characteristics have yet been found which show when the change in fuel was made.

A brief summary of observations will serve to outline the chief problems relating to Pecos glaze. The first glaze pottery made at Pecos, though so crude as to have suggested the term "Degenerate Phase," resembles the first well established Rio Grande type in the high percentage of granular pigment in the glaze and its thin application and slight spreading. Chemical analysis will show whether they are of the same composition. It would be natural for Pecos potters to obtain their raw glaze material from the same source as the Pueblos from whom they learned the technique. This earliest Rio Grande glaze paint is to a certain extent transitional between matte paint and typical glaze paint, for it was a comparatively satisfactory medium for design and, though fused, the large amount of granular pigment partially masked the vitreous luster. But as time went on there was an increasing trend toward the thicker, more lustrous, glazes characteristic of the late period, and while glaze was still used as a paint its decorative value was dependent almost entirely on its vitreous qualities. It does not necessarily follow, as has sometimes been argued, that the potter lost control of her material because it became thick and runny. These glazes may have been produced from choice, and certainly the practical potter would have realized that the thicker the application the farther it would run. The trend toward thicker glaze is interrupted by Glaze IV, which in general technique, color, and quality of slip, finish, and execution of design, marks the height of Glaze development at Pecos. Superficial resemblance of glaze paint of this type to that of Glaze I Red suggests a return to the same kind of material. But the refrac-

tive index of the glass shows that the resemblance is not as great as it appears and may be due more to thinness of application than to composition of the glaze. A comparison of kind and amount of pigment in the two types should throw more light on the significance of Glaze IV. In spite of great diversity, there are distinct differences in composition of the late as compared with the early glazes. The percentage of lead increased and the percentage of pigment decreased as the period advanced and in addition manganese, the principal pigment of Glaze I Red, is exceptional in Glaze VI. Attempts to duplicate the properties of the glazes with materials available to the Indian have emphasized the possibility that distinct ingredients were mixed by the potter, since glass with the refractive index of the late glazes was not made with a lead mineral alone but required the addition of clay or silica. A more complete analysis should bring evidence to bear upon the question of whether clay, alkali, or pigments were mixed with the lead flux and the extent to which changes in composition came about through the intent of the potter.

Since Pecos is peripheral in location and lagged in glaze development, the question of the origin of Pueblo glazing has not been considered, but may briefly be mentioned. Archaeological evidence points to the upper drainage of the Little Colorado as the area where lead glaze was first discovered by the Pueblo Indians and from whence the technique was carried to the Rio Grande area.[1] The accidental discovery of lead glaze could have been made in several ways. But perhaps the most probable explanation is suggested by the common occurrence of lead ores, particularly galena, and its alteration products such as cerussite, in veins with manganese and limonite. The accidental inclusion of lead ore with mineral pigment used for pottery would have resulted in a glaze, provided enough of the lead ore was present. The explanation assumes that the wares which preceded glaze were decorated with mineral paint, for had the earliest glazes appeared among a people who up to that time had used only organic paint, as at Pecos for example, there would be no basis for such a theory. However, St. Johns Polychrome, the Little Colorado Black-on-red ware made prior to the appearance of the first glaze, has a mineral paint; moreover, there is a variety of this ware on which the paint is thick and partially vitrified. Four sherds of the type, found among intrusives at Forked Lightning site, were analyzed microchemically. Their composition was variable, but three gave faint to moderately strong tests for lead, while iron and copper in different amounts were present in all three, and one contained a trace of manganese. Glazes may have been produced accidentally a number of times by the inclusion of lead ores with pigment before the potters learned what substance was making their paint glassy. But the first glaze-decorated bowl must have been a source of great wonderment and pride and would have stimulated experimentation to duplicate the results. It may have been some time before the material which produced the glaze was identified, and the sintered paint of St. Johns Polychrome suggests a period of experimentation. It is possible therefore that the analysis of Little Colorado matte paint will yield some information regarding the beginnings of glaze paint.

There can be little doubt that the first glaze pottery was highly esteemed, but several factors might have retarded the spread of the technique. The great popular-

[1] Haury, 1932, pp. 418-425.

ity of red ware among a people who had been limited in pottery decoration to black and gray is attested by the wide distribution of St. Johns Polychrome. Although this ware is found in most of the Black-on-white sites of the period in the Upper Rio Grande, potters of the area were unfamiliar with ferruginous slips and Rio Grande imitations of it have not been recognized. A glaze-decorated red ware was much more difficult to imitate, and even though the Little Colorado potters had been willing to pass on the results of their experience, new sources of glaze material, as well as red slip clay, would have had to be located if people at a distance from the original source attempted to make such pottery. The kind of lead ore first employed would influence the rapidity with which the knowledge spread. If galena with its striking luster and cubic cleavage were used, it would be easily recognized and the search for materials simplified. Galena has frequently been found in the course of excavation, but may simply have been treasured with other curiosities such as fossils and concretions. On the other hand, if an earthy, impure alteration product were used, its appearance might not be sufficiently distinctive to serve as a reliable guide to its immediate recognition, and many materials which looked like it might be tried before the search was successful. It would not be surprising, therefore, to find that a considerable period elapsed between the time when the first Little Colorado glaze bowl reached the Rio Grande by trade and the time when it was first successfully imitated. It is possible that the Rio Grande potters obtained raw glaze material by trade from the Little Colorado source before discovering it in their own locality. If there is a constant difference in composition of Little Colorado and Rio Grande glazes, it will be possible to answer this question. The higher percentage of copper shown in the Heshotauthla Polychrome as compared with the Glaze I Red, and the high ratio of copper to lead in Hawley's analyses of Pinedale glaze, give some encouragement.[1] The ceramic practices of the Little Colorado and Rio Grande differ in respect to tempering material and class of clay, and it will be interesting to determine how general and persistent the Little Colorado influence was at the time of glaze introduction. Thus the volume of trade in Little Colorado glaze ware, the length of time which it took the Rio Grande potters to learn the technique, the extent of Little Colorado influence, and the changes and developments which glazing underwent are all problems to be worked out in the detailed study of Glaze sites.

Speculations regarding the beginning and spread of the glaze technique have been indulged in merely to bring out problems and suggest a few lines of attack. Some questions may never be answered, but it would be folly to assume, *a priori*, that they cannot be. It is necessary to guard against preconceived ideas of what the primitive potter would or would not do under given circumstances, and to remember that the possibilities of discovery through trial and error and normal human curiosity are considerable. Variations within types and periods should not discourage thorough comparative studies, for uniformity is not to be expected with uncertain composition and firing conditions; technique, moreover, was not necessarily standardized at any time; different potters may intentionally have followed different practices. The apparently numberless variations which give an impression of confusion upon superficial examination take their proper place upon careful analysis.

[1] Haury, 1932, p. 422.

Above all it is essential that during the course of excavation, vigilant watch be kept for potters' materials and that the examples of poor glaze which have no exhibit value be recognized as equally important as the perfect museum specimens for recording the trials and errors of primitive potters.

MODERN WARE

PLAIN RED WARE

MEGASCOPIC OBSERVATIONS. The paste of Plain Red ware is friable and fractures irregularly. Grains of sand can generally be seen, and not infrequently fragments of siltstone, 2 or even 3 mm. in diameter, are scattered through the paste.

TEMPER. Typical Plain Red ware sherds are sand-tempered. Only one tuff-tempered specimen was found in a total of 38 representative sherds, i.e., 2.6% of the total. The sand is angular to subangular and grain size varies within wide limits; coarse fractures of siltstone and granite also occur. Quartz predominates over the feldspars and the latter are both fresh and weathered and include microcline and acid plagioclase. Flakes of mica, either biotite or a pale green mica, are always present. A few small fragments of green hornblende, are found in most sections; grains of zircon and blue-green tourmaline are also characteristic. Of rarer occurrence (found in half or less than half of the sections) are garnet, zoisite, augite, epidote, titanite and apatite. Although fractures of siltstone are not uncommon, they are generally composed of grains of much finer texture than the free grains in the paste and there is no evidence that the temper was directly derived from sandstone or siltstone.

TEXTURE. Average grain size—0.12 mm. in diameter; range—0.09 to 0.17 mm. Maximum grain size: average—1.12 mm.; range—0.80 to 1.92 mm. Average grading: very fine—65.6%; fine—26.8%; medium—5.2%; coarse—2.0%; very coarse—0.4%. *Volume of temper:* average—23.0%; range—19.1 to 27.1%.

CLAY. The paste is red-brown or dark gray in transmitted light, depending upon the degree of oxidation. In polarized light it is generally weakly birefringent, appearing deep red-brown, and well oxidized margins may be more brightly birefringent, even showing very slight orientation of particles. Some cores, on the other hand, are isotropic. Refractive index—1.556 to 1.565; a few specimens—1.547 or 1.537.

PHYSICAL PROPERTIES. *Color* range is limited. Seventy per cent of the sherds examined have dark gray or brown cores and red-brown margins. Cores are generally 15''''k (Dark Mouse Gray), less often Neutral Gray or Pale Neutral Gray, or 9'm (Carob Brown) and 13''i to m (Mikado Brown to Warm Sepia), rarely 17''''i (Hair Brown). Margins, which are usually less than one-third the thickness of the vessel wall, approximate most closely 9'k (Kaiser Brown), but duller, more yellow colors are occasionally found, including 15'' (Cinnamon), 11''i (Pecan Brown) less grayed, and 11'' (Vinaceous-Tawny) shading to 11''b (Onion-skin Pink). Sherds uniform in color are 9'k or slightly lighter. An exceptional sherd, tuff-tempered, has

a 15''''d (Pale Mouse Gray) core which shades through 9'''d (Light Grayish Vinaceous) to narrow margins of 13'' (Orange-Cinnamon). Oxidized at 850° C. for 30 minutes—11'', 11''a and 12'', rarely 11''c. Refired to 1200° C.—7'k or 7'm (Hay's Russet or Liver Brown). *Hardness.* 4 or 4.5, rarely 3.5. Unslipped surfaces are of the same hardness as the paste or slightly harder. Refired to 1200° C.—7+. *Modulus of Rupture.* Average—98 kg. per sq. cm.; range—74 to 133. *Strength of Vessel Walls.* Average—22 kg. per 2.5 cm.; range—14.5 to 35.5. *Apparent Porosity.* Average—24.5%; range—22.9 to 26.2%. Refired to 1200° C.: Average—11.8%; decrease—51.8%.

Slip. Only 19% of the sherds examined were slipped. The presence of slip is often indicated by color and by flaking or wear. The character of the surface finish is plainly shown in thin section, since the slip viewed in cross section appears as a definite layer distinct in color and texture from the paste. In the majority of Plain Red ware sherds thin sectioned the marginal area does not differ from the remainder of the section or shows only such color variation as is caused by the difference in compactness of the clay. *Slip Color* is typically 5'k (Brick Red) or approaches 7'i (Vinaceous-Rufous) but is clearer; where the polish has rubbed off it is 9''b (Japan Rose). Oxidized at 850° C. for 30 minutes—9'' (Testaceous), or 7'i; 11'' where worn. Refired to 1200° C.—5'i (Dragon's-blood Red). *Hardness.* 1.5 to 3. The slip is impermanent and is easily rubbed off from areas where the polish has worn. Refired to 1200° C.—7+. *Thickness.* 0.03 to 0.06 mm. *Finish and Wear.* The slip is well smoothed and highly lustrous but usually badly worn. *Optical Properties.* The clay is nearly opaque in transmitted light, bright orange-red in incident light. Refractive index—1.573 to 1.603. Texture is fine and mineral inclusions are rare.

Firing. Calcite was found in 18.7% of the sherds examined. Reddish margins indicate an oxidizing atmosphere but pastes were seldom fully oxidized.

PLAIN BLACK WARE

Megascopic observations. Sand temper was found in 54% of the Plain Black ware sherds examined microscopically; the remaining 46% was tuff-tempered. The two varieties can sometimes be distinguished megascopically. The paste of tuff-tempered sherds, compared with that of the sand-tempered specimens, is finer in texture and generally harder; the vessel walls of this variety are characteristically thinner and the surface more uniformly and better smoothed. As both were subject to reducing conditions in firing, there is no constant difference in paste colors. The paste of the tuff-tempered variety is typically homogeneous in appearance; a scattering of minute opaque white flecks may suggest the presence of tuff in the paste, but a 10-power lens also reveals a few grains of quartz and feldspar, which make megascopic identification difficult. If a sherd is held in direct sunlight and moved slightly, light scintillates from innumerable minute flecks of tuff, whereas in sand-tempered sherds only scattered mineral grains reflect the light. The fracture of tuff-tempered Plain Black ware is usually straight and square.

The paste texture of the sand-tempered sherds is variable; a few specimens are fine enough to be confused with the tuff-tempered ones, and one untempered sherd

was found, but in the majority of sherds grains of quartz and feldspar can be detected with a 10-power lens, often with the naked eye, while in many there is a scattering of coarse particles, large grains of sand, fractures of sandstone and lumps of limestone, a millimeter or more in diameter, which give the paste a non-homogeneous appearance. The fracture is irregular and uneven.

SAND-TEMPERED PLAIN BLACK WARE

Temper is stream sand composed of subangular grains of quartz and feldspar, the former preponderating. The feldspars include microcline and acid plagioclase. Mica, usually a pale green variety, occasionally biotite or muscovite, is always present; splinters of blue-green hornblende are common; basaltic hornblende is rare; small grains of zircon, garnet, augite, zoisite and epidote occur sparingly. Fractures of sandstone, limestone and granite are occasionally found.

Texture. Average grain size—0.13 mm. in diameter; range—0.11 to 0.15 mm. Maximum grain size: average—0.93 mm.; range—0.64 to 1.28 mm. Average grading: very fine—56.4%; fine—36.4%; medium—4.4%; coarse—2.8%. *Volume of temper:* average—24%; range—excluding exceptional untempered sherd—17 to 30%.

Clay. Olive or dark gray in transmitted light, usually isotropic, a few specimens weakly birefringent. Refractive index—1.556 to 1.565.

Physical properties. *Color.* 15″″″i to k and b (Deep to Dark Mouse Gray and Light Mouse Gray); dark browns differing in depth and intensity are also found, particularly in bowl sherds; they include 13‴m (Bone Brown), the most common, 13″″k, and 13″i to m (Fuscous, and Mikado Brown to Warm Sepia). The majority of sherds are uniform in color except for very narrow margins of dark gray or sooty black, but occasionally there is a margin of 9′k or 11″i (Kaiser Brown or Pecan Brown) just beneath the outer black coat. Oxidized at 850° C.—generally 11″ to 11″a (Vinaceous-Tawny or paler), occasionally 13″b (Vinaceous-Cinnamon) or 12″. Refired to 1200° C.—7′k (Hay's Russet) or 7′m (Liver Brown). *Hardness.* 4 to 4.5, occasionally 3.5. Refired to 1200° C.—7+. *Modulus of Rupture.* Average—96 kg. per sq. cm.; range—79 to 121. *Strength of Vessel Walls.* Average—22 kg. per 2.5 cm.; range—18 to 25. *Apparent Porosity.* Average—24.1%; range—21.8 to 25.8%. Refired to 1200° C.: Average—15.0%; decrease—37.8%.

Surface. No slipped specimen was found in a group of 21 representative sherds. Surface colors range from 15″″″ (Mouse Gray) or Neutral Gray to shades darker than 15″″″m (Blackish Mouse Gray) or Dusky Neutral Gray, *m*, and are occasionally splotched with 13‴i (Army Brown). Hardness is the same as that of the paste, generally 4 to 4.5. Surface finish is variable but the majority of specimens show the horizontal strokes of a smoothing tool and approximately half of the sherds have a lustrous surface.

Firing. Calcite was found in 22% of the sherds examined. No example of dehydrated muscovite occurred. Dark gray and blackish surfaces indicate reducing conditions, but the brown cores of some specimens show that such an atmosphere was not always maintained long enough to completely reduce the paste. Impurities

in the paste of some sherds cause extreme bloating upon refiring to 1200° C. and slight bloating and deformation is noted even at 850° C.

TUFF-TEMPERED PLAIN BLACK WARE

TEMPER. The tuff is composed mainly of fine flowage flakes and some forked or irregular fragments; pumiceous particles are exceptional. Mineral grains are usually sparse though in a few specimens they equal the tuff in volume, and megascopically the paste appears to be sand-tempered. Quartz and feldspars are the principal minerals. Micas, blue-green hornblende, zircon, augite, epidote, calcite and magnetite occur sparingly.

TEXTURE. In typical specimens the majority of tuff flakes are between 0.08 and 0.16 mm. in diameter; in very fine textured sherds they are 0.03 to 0.05 mm. in diameter. The maximum size in 0.24 mm. but flakes exceeding 0.16 mm. are rare. *Volume of temper* could not be determined by the Rosiwal method or by chemical separation.

CLAY. Light brown in transmitted light, brightly birefringent. Refractive index—1.537.

PHYSICAL PROPERTIES. *Color* is principally in the range of 15''''' (Mouse Gray). The majority of sherds are either 15''''' or 15'''''i to k (Mouse Gray or Deep Mouse Gray to Dark Mouse Gray) with margins of 15''''' or 15'''''b (Mouse Gray to Light Mouse Gray). Variations are 15'''''d, 17'''' (Drab) and 17''''i (Hair Brown). Oxidized at 850° C. for 30 minutes—13'' to 15'' (Orange-Cinnamon to Cinnamon) or 12''. Refired to 1200° C.—7'k or 7'm (Hay's Russet or Liver Brown). *Hardness.* 3 to 5, generally 3.5 to 4.5. Refired to 1200° C.—7+. *Modulus of Rupture.* Average—153 kg. per sq. cm.; range—152 to 155. *Strength of Vessel Walls.* Average—26 kg. per 2.5 cm.; range—20 to 31. *Apparent Porosity.* Average—24.9%; range—21.4 to 29.3%. Refired to 1200° C.; average—5.0%; decrease—79.9%.

SLIP. The majority of sherds are unslipped, only 10.5% of the sherds examined being slipped. *Color.* Blacker than Neutral Gray, *m* or 15'''''m. Oxidized at 850° C. for 30 minutes—9''k (Walnut Brown). *Hardness.* 4 to 5. *Thickness.* 0.02 to 0.03 mm. *Finish and Wear.* Highly polished; shows horizontal strokes of polishing tool. Rarely crazed or abraded.

FIRING. Calicite was found in 75% of the sherds examined. Colors indicate that reducing conditions always obtained in the final stage of, if not throughout, the firing.

MODERN PAINTED WARE

MEGASCOPIC OBSERVATIONS. The majority of Modern Painted ware sherds from Pecos are tuff-tempered, but sand-tempered sherds also occur. Although it is sometimes impossible to identify the tempering material megascopically, the two groups show certain variations in color and texture. The few sand-tempered sherds have a darker color range and a coarser, more friable paste than the tuff-tempered specimens; the former are also noticeably cruder in workmanship, often being carelessly smoothed, the slip thin and streaked and the design poorly executed.

Tuff-tempered sherds have a fine, homogeneous texture. Inclusions, opaque white flakes of tuff, plates of mica and small grains of quartz and feldspar, are rarely seen. The fracture is usually relatively straight and square.

TUFF-TEMPERED MODERN PAINTED WARE

Temper. In the group of 33 representative sherds studied 85% were tuff tempered and the remaining 15% were tempered with stream sand. The tuff is very similar to that of Biscuit ware and cannot be distinguished from it either by texture of the glass or by mineral inclusions. Fine flowage flakes are most common, though occasionally forked and lunar pieces from bubble rims predominate. The scattering of mineral grains is made up largely of quartz and clear feldspar including both microcline and acid plagioclase. Flakes of biotite and grains of calcite are numerous in most sections. A few small fragments of hornblende, green or olive in color, are generally present. Flakes of muscovite are found in half the sections. Small grains of epidote, zoisite, augite, titanite, zircon and magnetite occur in less than half of the sections studied.

Texture. The majority of tuff flakes are between 0.08 and 0.16 mm. in diameter. The largest flakes are from 0.16 to 0.24 mm. in diameter. Grains of quartz and feldspar have the same range in size as the tuff particles. *Volume of temper* cannot be determined by the Rosiwal method or by chemical separation.

Clay. Light brown in transmitted light, brightly birefringent. Refractive index—generally 1.532, occasionally 1.547.

Physical properties. *Color* is exceptionally uniform and core-margin variations are characteristic. Margins, either wide or narrow, are 13″b, 13″ or 15″b (Vinaceous-Cinnamon, Orange-Cinnamon or Pinkish Cinnamon). Cores are usually 15‴″b (Light Mouse Gray). Variations in margin colors are 15″ (Cinnamon) slightly grayed and 13‴ (Fawn Color). Exceptional cores are Deep Neutral Gray, *i*. The rare sherds which are uniform in color have the same range as typical margins. Oxidized at 850° C. for 30 minutes—13″ (Orange-Cinnamon). Refired to 1200° C.—9′m, 9″m, 11″m and 7′m (Carob Brown, Burnt Umber, Vandyke Brown, and Liver Brown). *Hardness*. 3 or slightly under. Refired to 1200° C.—7. *Modulus of Rupture*. Average—140 kg. per sq. cm.; range—100 to 169. *Strength of Vessel Walls*. Average—43 kg. per 2.5 cm.; range—25 to 65. *Apparent Porosity*. Average—30.1%; range—27.4 to 34.6%. Refired to 1200° C.; Average—1.3%; decrease—95.7%.

Cream slip. *Color*. 17‴f (Tilleul-Buff), or slightly paler and more grayed; occasionally as deep as 17‴b (Avellaneous); incompletely oxidized, 17⁗d to f (Drab-Gray to Pale Drab-Gray). Oxidized to 850° C. for 30 minutes—15″e to f slightly more grayed (modified Pale Pinkish Cinnamon). Refired to 1200° C.—usually whiter than 17⁗f, a few specimens are 21⁗d (Smoke Gray). *Hardness*. 4 to 4.5, rarely 3. Refired to 1200° C.—6.5 to 7; completely vitrified and usually finely vesicular. *Thickness*. Usually 0.14 to 0.29 mm., occasionally 0.06 to 0.09 mm. *Finish and Wear*. Very well smoothed but never highly lustrous; deeply crazed on most specimens, abraded or peeled on some. *Optical Properties*. Dark brown or gray in transmitted light, whitish in incident light, weakly birefringent. Refractive index

—1.506, occasionally 1.524. Exceptionally fine and dense in texture, free from mineral inclusions but sometimes contains fragments of tuff.

Red slip. *Color.* Slightly clearer than 5′k (Brick Red), 9′k (Kaiser Brown) and 9″i (Cacao Brown). Oxidized at 850° C. for 30 minutes—7″i to 9″i less grayed. Refired to 1200° C.—5′k or 7′l. *Hardness.* 3.5 to 4.5. Refired to 1200° C.—7+. *Thickness.* 0.06 to 0.11 mm. *Finish and Wear.* Well smoothed with nearly horizontal strokes. Highly lustrous, very rarely crazed, seldom abraded. *Optical Properties.* Opaque; clear red in incident light.

Black paint is organic. *Color*—generally blacker than 15‴″m or Neutral Gray, *m.* Oxidized at 850° C. for 30 minutes—15‴″ to 15‴″i. Smooth in texture but like the cream slip never highly lustrous. Usually penetrates the slip to approximately one third its thickness.

Red paint. A ferruginous clay having the same color, hardness and optical properties as the slip. It is rarely polished.

Firing. Calcite was found in 70% of the sherds examined. Muscovite, present in approximately half the sherds, in no instance shows evidence of dehydration. The birefringence of the paste is definitely weakened when sherds are refired to 850° C. The color of the margins of vessel walls indicates that the firing atmosphere was oxidizing but such conditions were rarely maintained long enough to bring the paste to a uniform state of oxidation.

SAND-TEMPERED MODERN PAINTED WARE

The number of sand-tempered Modern Painted ware sherds available for study was limited, and consequently only a few observations are recorded.

Temper. The stream sand of the sand tempered subtype is subangular and poorly assorted. Quartz grains are more numerous than feldspar. Flakes of mica, either biotite or muscovite, are always present. Calcite is not found but patches of impure limestone are characteristic. Small grains of hornblende and zircon are generally present, while garnet and ziosite are occasionally noted.

Texture. Average grain size—0.10 mm. in diameter; range—0.08 to 0.12 mm. Maximum grain size: Average—1.22 mm.; range—0.80 to 2.0 mm. Average grading: very fine—71.0%; fine—25.0%; medium—3.5%; coarse—0.5%. *Volume of temper:* average—23.6%; range—19.2 to 27.7%.

Clay. Brown or gray in transmitted light, generally isotropic. Refractive index 1.555 to 1.565.

Physical properties. *Color.* The sand tempered sherds are generally darker and redder in color than the tuff-tempered ones; cores are 15‴″k (Dark Mouse Gray) and margins are 9′k, 11′k, or 11″ (Kaiser Brown, Hazel or Vinaceous-Tawny) shading toward the cores to 13″. Sherds uniform in color are 9′k. Oxidized at 850° C. for 30 minutes—9′i (Ferruginous) or 11″i (Pecan Brown) less grayed.

Slips and paints are indistinguishable from those of tuff-tempered Modern Painted Ware.

Firing. Calcite was not found in the paste. Flakes of muscovite showed no evidence of dehydration. The characteristic core-margin variations indicate that

oxidizing conditions were not maintained long enough to completely oxidize the paste.

INTERPRETATION OF TECHNOLOGICAL DATA

The Modern wares—Plain Red, Plain Black, and Painted—came into general use during the period of upheaval which followed the Pueblo Rebellion. The art of producing glaze was lost at this time and pottery was again decorated with an organic pigment, the use of which had been uninterrupted in the Biscuit area since Black-on-white times. Certain physical properties of the Modern wares, nevertheless, record the persistence of methods and materials of the Glaze period; ferruginous clays, unknown in Black-on-white times and never applied on Biscuit ware, continued in use in the Modern period for slips and paint. Since an oxidizing atmosphere is necessary for the production of clear reds, it is not surprising to find that firing conditions, as evidenced by paste color, were similar to those of the Glaze rather than the Black-on-white period. An adaptation from Biscuit ware is found in the quality of the slip clays used on Modern Painted ware. New features, which must have resulted from independent experimentation, appear in these wares. Pottery intentionally blackened by smudging was made for the first time in the Upper Rio Grande area, and a type of non-culinary ware, which depends for aesthetic appeal upon color and surface finish rather than upon painted design, also makes its appearance. Pebble polishing became a common technique and surfaces were more lustrous than in any of the earlier wares. Whether these innovations originated with some gifted potter, or whether they resulted from Spanish or some other foreign influence, is still a matter of conjecture, nor can we do more than speculate on the question of whether smudging of pottery was a natural development from the use of dung fuel. It is, however, easily demonstrable that these wares, though distinct in style and technique, drew largely upon practices followed by earlier potters.

The pastes of the Modern wares, like those of every other ceramic group from Pecos, contain some foreign tempering material, in this instance, tuff. The three wares exhibit an interesting difference in the proportion of tuff-tempered specimens, for this temper is very exceptional in Plain Red ware, occurs in approximately half the Plain Black specimens, and is present in the great majority of Painted ware vessels. The contemporaneous occurrence of vessels with tuff temper and with sand temper from local sources, both sorts of vessels being stylistically identical, recalls the condition which existed in Black-on-white times. The theory that vessels were obtained in trade rather than that temper was imported has already been discussed at length. The probability that the tuff-tempered subtypes of the Modern wares were imported is strengthened by the fact that the clay of these specimens differs in color and optical properties from that in the sand-tempered subtypes. The clay of tuff-tempered sherds is generally clearer and lighter in color, has a lower refractive index, and is more strongly birefringent than the paste of the sand-tempered sherds. The refractive indices especially indicate that clays of the two subtypes came from distinct formations, and in the other ceramic groups studied only certain tuff-tempered types, Biscuit and Biscuitoid, are characterized by paste having a low refractive index. The occurrence of tuff-tempered vessels, therefore, strongly indi-

cates that Pecos was once more influenced by, and to a certain extent ceramically dependent upon, the communities of the Santa Fe region.

Plain Red illustrates more clearly than the other Modern wares the technological characteristics of the late period, since it is made, with few exceptions, entirely of local material. Plain Red ware is tempered with stream sand; there seems to have been no attempt whatsoever to obtain fine material of a uniform grade by using ground or disintegrating siltstone, a custom which was beginning to break down in Glaze V times. Plain Red pastes are accordingly coarser and more friable than those of the Glaze period. The frequent occurrence of calcite proves that firing temperatures were low. Poor firing and indifference in the choice of temper are in keeping with the careless finish of many vessels. The ware appears at a superficial glance to have been slipped, but upon more careful inspection a red slip can be detected with certainty on approximately one-fifth of the sherds. The properties by which it can be recognized are color and hardness, distinct from those of the paste, and a tendency to become flaked or abraded. It is very soft (2 to 3), readily soluble in hydrochloric acid, and the slipped specimens are often badly worn. The absence of slip upon most specimens was proved by microscopic examination. The limited use of a poor slip and the presence of numerous unslipped vessels suggest that a convenient source of good quality red-burning clay was not known at this time. Such clays were used in Glaze times, particularly as pigments for solid design, but as only relatively small amounts were required, they may have been collected from a distant source or obtained in trade. High-grade ocher clays have been found at a number of places in the Galisteo Basin; one occurs within a half mile of San Cristobal, an important Glaze site, but none have been located in the region about Pecos. A hard, clear red slip, as well as the soft impermanent one, is occasionally found on Plain Red bowls, but the difficulty of obtaining it is attested by its rarity.

Strangely enough, the only vessel form in Plain Red ware was the bowl. Dr. Kidder (see p. 287) has concluded that Plain Red ware ollas were not made, because sherds from the shoulders of such vessels have not been found, and sherds from olla necks or bases may have come from the type of Painted ware having a white-slipped shoulder band, and red neck and underbody.[1] Technological evidence substantiates this conclusion, for all the red olla neck sherds, like Painted ware and unlike Red ware, were tuff-tempered. The clay of the olla neck sherds is also of the same character as that of Modern Painted ware and distinct from that of Plain Red ware. Finally, the necks, in contrast to the Plain Red bowls, have a highly lustrous, clear red, permanent slip. The reason for the lack of variety of vessel form in Red ware is not obvious. Greater skill is required to mould an olla than a bowl, and a large, tall vessel would be particularly difficult to make with a clay low in plasticity, as the base would not easily hold the weight of the upper body. But Plain Black ollas were evidently made from Pecos clay, and the strength, hardness, and apparent porosity of the Red and Black ware pastes are nearly identical. The fact that Plain Red ware ollas were not made is, therefore, probably to be explained by custom rather than by limitations imposed by materials.

[1] Vol. I, Frontispiece.

Plain Black ware, though more often gray than black, seems always to have been intentionally smudged when fired. Although types of smudged pottery are known from much earlier horizons in other parts of the Southwest such pottery seems not to have been in use at Pecos until well into the historic period. There is no evidence that the method of producing Black ware was learned from another Pueblo group. The use of dung fuel, though not essential to the technique, may have facilitated the making of Black ware. In any case, it is very improbable that the first Rio Grande Black ware was made at Pecos, in view of the general evidence that Pecos potters were not ceramic leaders at this time. The large number of tuff-tempered specimens suggests that the ware may have been introduced from the Santa Fe area, where it has continued to hold an important place throughout the historic period. A study of Pecos stratigraphic material might disclose a significant difference in the proportion of tuff-tempered specimens during the period of introduction of Black ware and after it was well established. But as such evidence is not available, conclusions regarding the origin of Pecos Black ware must await future investigation.[1]

The two subtypes of Black ware, sand- and tuff-tempered, although made with different clays and tempers, are nearly identical in certain properties; they have the same average apparent porosity and average the same in hardness, although the tuff-tempered specimens are somewhat more variable than the sand-tempered ones. The tuff-tempered paste is the stronger of the two, but the weakness of the sand-tempered subtype is offset by thicker vessel walls. Textural differences resulting from the relative coarseness of the temper are sufficiently marked in some specimens to serve as a basis for macroscopic classification. The refractive index of the clay is consistently lower in the tuff-tempered as compared with the sand-tempered sub-

[1]Since the above was written 30 Plain Black ware sherds have been identified in Cut 4 of Pecos Test XXI. The total number of sherds in this cut is 413 and the Black ware sherds were originally classed with the Plain Culinary (Vol. 1, p. 40). The Black ware sherds differ from the culinary sherds primarily in surface texture, the former being tool finished on both interior and exterior, generally well smoothed and occasionally lustrous, while the latter, being finger-finished, have a rough granular surface. True Black ware sherds are not found in earlier levels of Test XXI but in Cuts 5, 6, and 7 there are a few culinary sherds having tool-finished interiors. Only 10% of the Plain Black ware sherds of Cut 4 are tuff-tempered, which fact does not support the suggestion that Plain Black ware may have been introduced from the Santa Fe area. There may not actually have been a complete or marked change in firing technique with the introduction of Black ware. These sherds are no more completely blackened than culinary sherds with which they are associated, though in the latter case repeated use over the fire and absorption and charring of organic matter have largely affected color. A reducing atmosphere and restricted blackening sometimes occurred in the firing of all wares. When culinary pots were fired, the fuel may have been heaped over the pottery without the regard to contact of fuel and vessels and to draft which was necessary in the firing of light-slipped wares. Results of such careless firing might naturally suggest the complete and intentional smothering of the fire. The unevenness of blackening and the preponderating gray tone of the early Black ware sherds indicate that the technique of smudging was not at once mastered. Additional note by A. V. K.: While the above-mentioned sherds may be examples of the earliest Plain Black ware at Pecos, I do not believe that they are prehistoric, in spite of the fact that they emanate from Cut 4 of Test XXI. This cut was taken in earth closely underlying the late plaza level, and it is possible that a pit or other intrusion may account for their presence. In no other part of the site was Plain Black observed to occur in debris older than the later part of Glaze V.

type. Although examples of the two subtypes comparing favorably in surface finish can be found, there is, nevertheless, a larger proportion of well smoothed and polished specimens in the tuff-tempered than in the sand-tempered group.

Plain Red ware and the sand-tempered subtype of Plain Black ware exhibit no significant differences in physical properties, the hardness and porosity of the two being practically identical, and although the Red ware is slightly stronger than the Black, the data do not indicate a difference in clays. Both subtypes of the Black ware, like the Red ware, are generally unslipped. The technological evidence, therefore, suggests that the Pecos Black and Red wares differ only in the way in which they were fired.

Pecos Plain Black ware is technically superior to that made by present-day Pueblos, being both harder and stronger. The superiority of the early Black ware may undoubtedly be attributed in part to longer or higher firing, for tuff-tempered Black ware from Pecos has the lowest porosity of any similarly tempered type tested in the present investigation and falls within the same range as the majority of sand-tempered wares.

Early Black ware is grayer in color than modern pottery made by the same technique.[1] Several factors may cause variability in color of smudged ware; the length of smudging, the degree of exclusion of air, condition of the fuel and temperature when the fire was smothered, and the density of the paste. There is no uniformity among present day potters in length of smudging; Maria and Julian of San Ildefonso keep the fire smothered for approximately an hour before removing the pottery, while a Santa Clara potter took only ten minutes for the smudging process, yet her jar was perfectly blackened. A long exposure to reducing condition is therefore not necessary, provided there is a dense smoke and flames do not burn through the covering of fine dung. It is customary at the present time to smother the fire before the dung chips are completely burned out; consequently, there is plenty of carbonaceous matter left to produce a dense smoke. Since the hardness and strength of the early Black ware indicate that it was well fired, it is possible that the relation between unconsumed fuel and a heavy smudge was not at first recognized and most of the fuel was allowed to burn out before the fire was smothered. It remains to be discovered experimentally whether a paste which has been made dense and hard in firing is as easily blackened as one which is open and porous. The interiors of gray vessels are often well blackened and in these instances the only difference in paste is that caused by polishing.

Few of the early Black ware specimens are as highly lustrous as those made today. Clays, however, differ in the degree of luster which they assume upon burnishing, and the fact that these early Black ware vessels do not have the fine sheen of the modern may be due, in part at least, to quality of the clay rather than neglect on the part of the potter. The differences between early Black ware and that made by Pueblo potters today may largely be explained by the potters' purpose. The first Rio Grande Black pottery was utility ware; it had to have the hardness and strength necessary for household use, whereas this ware is now made only to sell; fine finish

[1] The method of making Black ware followed by San Ildefonso potters is described by Guthe (1925, pp. 74-75).

has become a prime requisite, but high technological standards are no longer demanded.

Modern Painted ware from Pecos is, with few exceptions, tuff-tempered; consequently, it is tentatively classified as intrusive. The rare sand-tempered specimens, though stylistically the same, have a more friable paste and are cruder in workmanship, particularly in the execution of design. The paste of the normal type is similar to that of tuff-tempered Plain Black in optical properties, but is noticeably softer and more porous. The difference in physical properties may partially have been caused by firing treatment, since the organic pigment of the Painted ware would not withstand long or high firing. The presence of calcite in approximately two-thirds of the tuff-tempered specimens of both wares, however, proves that a relatively low temperature range was generally used in this period.

The slip clay of Modern Painted ware resembles that of Biscuit ware in color, optical properties and thermal behavior. A clay having similar properties is used by modern Keres potters of Santo Domingo and Cochiti and is obtained from them by Tewa Indians of San Ildefonso. It has been found by experiment (see p. 417) that certain peculiarities of the Santo Domingo clay make it particularly suitable for the use of organic paint, since it holds and protects the carbonaceous matter much more effectively than most clays. The fact that the paint of Biscuit and Modern Painted ware is usually dark gray or nearly black, in contrast to the light or medium gray paint of Black-on-white types, indicates that the former class of clays had the same effect upon organic pigment as the Santo Domingo clay, and the custom of using this kind of clay has evidently been uninterrupted since Biscuit times. The slip of Modern Painted ware in contrast to that of Biscuit ware is usually badly crazed, which fact shows that it had higher shrinkage than the body. Occasionally the slip contains tuff. This is the only example among the wares found at Pecos of a possible attempt to counteract the shrinkage of a slip with temper. The slip of the sand-tempered subtype of Modern Painted ware has the same optical properties and thermal behavior as that of the tuff-tempered subtype, and since this kind of clay does not occur in the Pecos region it must have been obtained from the Rio Grande source, if the classification of this subtype as indigenous is correct. Petrographic studies have not yet been carried far enough to learn whether sand from Glorieta Arroyo can be distinguished from that of all the major tributaries of the Rio Grande in the Santa Fe region, and consequently it cannot be established that a particular sand-tempered type could not have come from some other Pueblo which was also following the custom of tempering with sand. The fact, however, that the Rio Grande Pueblos were generally using tuff temper in this period strongly indicates that the sand-tempered subtype is a local product at Pecos, and the difficulty of obtaining the slip clay probably explains the scarcity of specimens of this subtype. These sand-tempered Modern Painted vessels, therefore, present an exceptional opportunity for investigating the problem of importation of ceramic materials.

Thus the three Modern wares record the renewed dependence of Pecos during the period of its decline upon the Rio Grande Pueblos. Specific data regarding the introduction and development of these wares is meager from lack of stratigraphic material. But the sand-tempered subtypes which are probably of local origin disclose

a growing carelessness in technique. They likewise show that the supply of good quality slip clays was limited. The question whether such clays were imported is a significant problem for future technological investigation.

CULINARY WARES

The descriptive outline of the culinary types has been omitted because few of the physical properties are significant and pastes are not distinctive of any one type as defined by workmanship. Color is usually masked by carbon, imperfect welding of coils and unequal thickness of vessel walls resulting from indentation render transverse strength determinations valueless, and porosity is affected by impregnation with carbon. Stream sand is the most common tempering material in all periods. Other kinds of temper occur in several types but are not limited to a single type. In the study of paste, ninety-seven representative sherds from Forked Lightning and Pecos were thin sectioned and in addition the stratigraphic material from Tests D and VI, Forked Lightning and Test XXI, Pecos was examined with the binocular microscope. Results of the analysis will be summarized in the discussion of types, but the workmanship of culinary ware must first be considered.

In many types of Pueblo culinary ware the structural coils have been carefully preserved and regularly indented. The skill and fine craftsmanship often shown in these pots are a source of wonder and admiration, yet the corrugated wares have been much less thoroughly studied than have the painted wares. The general appearance of the pottery is usually described without reference to the way in which the coils were handled, perhaps because statements regarding method of manipulation may have seemed speculative and of little value. Yet the actual workmanship is not only the most interesting feature of the ware but also presents the logical basis for classification. It is possible to recover much of the detail of construction by close observation and systematic experimentation. The characteristics which proved important in the study of Pecos culinary types are, therefore, briefly discussed as a start toward ultimate standardization of description.

Direction of coiling. There are three possible ways of determining the direction of coiling: from the beginning of the coil, from coil laps, and from the form of indentations. Entire jars or basal fragments in which the coil was preserved from the start offer the most direct evidence, but such specimens are not often found in sufficient numbers to warrant generalization, especially as the coils are sometimes indistinct and certain types of culinary vessels are smooth below the shoulder. The lap made at the end of a coil when a new one was started also gives positive evidence of the direction in which the coil was laid, for in corrugated wares the vertical overlapping was always on the outside (fig. 254, *g*, *n*); therefore, if a new strip with its end on top extends to the right, the coiling was in a counterclockwise direction.[1]

[1] The direction here referred to is that in which the body of the vessel was built after the base was moulded and turned to its normal position. When coils were to be preserved on the base of a vessel it was necessary to start it in an inverted position resting on the exterior rather than the interior of a support. During this stage, coiling was in the opposite direction from that of the body. While it might seem

But even these marks of construction are not numerous, for abutted coil ends were usually carefully obliterated. In certain of the corrugated wares with decorative indentations, the direction of coiling is shown by the relief pattern, for the depressions of the wavy surface are seldom symmetrical and usually have a shallow trough where the thumb rested and a steep side which was produced when the clay strip was pushed back upon itself. Indenting naturally progressed in the same direction as coiling, and pressure was either direct, backward, or downward, or a combination of these, for pressing upward would tend to pull the coils apart and pressing forward in the direction of coiling interferes with the succeeding indentation and leaves no distinct pattern. The most distinctly asymmetrical impression is made with the edge of the thumb pressing back or down; the abrupt side of the indentation is then opposite to or away from the direction of coiling. In these types therefore the form of the indentation shows plainly whether coiling was clockwise or counterclockwise. But if the indentation is made with the ball of the thumb and direct pressure, a more nearly symmetrical impression is left and the direction of coiling cannot be determined. It has also been found by trial that if the side of the thumb is used to pinch the coil and pressure is away from the thick of the thumb instead of toward it, as is usual, the position of the abrupt side of the indentation is reversed or toward the direction of coiling. Indentations made by pressing away from the thick of the thumb lack sharpness of relief and are more likely to show the impress of the nail (fig. 309, *c*). They can be recognized by one familiar with the patterns produced by the thumb in different positions and with different directions of pressure, but have not yet been found on prehistoric pottery. This method of indentation probably was rarely, if ever, used because of the awkwardness of the motion.

Spiral or ring coil.[1] The most elaborate types of corrugated ware are coiled in a continuous spiral, while some of the simpler ones and the smoothed wares of the present-day Pueblo potters are built up by successive rings. The reason for spiral coiling of indented ware is obvious, for if each tier of coils were closed, indentations would meet when the ring was encircled and there would be an irregular, unsightly finish. On the other hand, a more even edge is maintained by ring structure than is possible with spiral coiling, the degree of unevenness with the latter method depending upon the size of the coils. Although it seems probable from a

more logical to designate the direction in which coiling was begun, most of the coiling was done in the upright position and all smoothed vessels, started on the interior of a support were coiled entirely in this way. As all sherds, except those from the center of the base, moreover, are viewed in the upright position the designation here adopted has proved less confusing than the other alternative.

[1] There is some looseness in the use of the terms *coil* and *corrugated*. They are here used in the following senses: *coil* refers to a structural part, *coiling* to a process in pottery making. A vessel is considered coiled if it is built up by successive rolls of clay placed either in rings or spirally, irrespective of subsequent smoothing and without reference to the methods of shaping, whether by hand and gourd rind tool or with paddle and anvil. *Corrugation* is the horizontal undulation of the surface produced by coils which were carefully preserved in the welding and finishing process. *Indentions* are systematic depressions intentionally made either with thumb, finger, or tool. Hence an indented type with coil-edge retained is called *Indented Corrugated*, but if the coil were effaced the type is classed as *Indented Blind-corrugated* since the character of the relief pattern is determined largely by the indentation, and the coil functions in the decorative effect only in keeping the indentations even.

consideration of these facts that spiral coiling was employed principally for indented and fine corrugated types, many more data are necessary to trace fully the changes and developments which took place in the technique of coiling in the Southwest, and it is important that entire specimens be studied for evidence of ring or spiral coiling.

Lapping of the coils. The importance of the amount of vertical overlap as determining the width of the bearing surface and therefore the strength of the juncture was stressed many years ago by Holmes.[1] The abutting of one coil directly above the other was impracticable for most of the indented types, as both structural strength and aesthetic effect are gained by the overhang or shingling of one coil above another; also the lower edge of a coil was not usually pressed tightly against the previous coil and for this reason a wider overlap was necessary. The actual amount of overlap can be determined in specimens in which a horizontal break has followed the juncture of coils or from vertical cross-sections in which lines from imperfect welding indicate the direction of the plane upon which the coils were united. Imperfect welding is also sometimes shown on the inner surface by lines along coil junctures. The angle of the plane of coil junctures to the vessel surface is sometimes shown by textural features of the paste seen in vertical cross-section, particularly when there are platy inclusions, as mica or tuff, which are pressed into parallel position by the welding of coils.

Flattening of coils and obliteration of junctures. A new coil when joined to the previous one was partially flattened either before indenting or by the process of indenting. Thorough joining of the coils was essential to the soundness of the vessel and would not be neglected for decorative effect by the practical potter. The safest procedure is to press the coils together, thus flattening them somewhat, before commencing to indent, for in the latter process the coils are pressed only at intervals and there is danger that the spaces between may not be perfectly joined. The amount of welding and flattening a coil receives, preliminary to indenting, largely determines the relief of the indented pattern, and it is generally possible to tell from the contour of coils whether they were flattened before indenting. In some types of indented ware, lines between coils were completely effaced, though careful and regular indentations were made. The structural features of this type are so nearly obliterated that the method of workmanship is difficult to follow. The Rio Grande form is described on p. 560 as Blind-corrugated.

Placement of the indentation. When the coil is indented, the thumb (with fingers applied as a brace on the interior) may be placed on the upper, the middle, or on the lower edge of the coil. The indented pattern and general appearance of the work vary considerably as different parts of the coil are pinched (fig. 309, *e*, *g*).

Method of indenting. The direction, width, and relief of indentation and the finger-print pattern sometimes show plainly the position of the thumb during the manipulation of the coils. A clear understanding of the effect of these factors can be gained by making a series of models, keeping in mind the fact that the coils must be thoroughly united, that the position of the hand should be easy and natural, and that the work should be fully visible. If the clay is always mixed to the same

[1] 1886, pp. 274-277.

degree of plasticity and if size of coil, amount of overlap, degree of flattening, part of coil pinched and pressure applied are all kept constant, the indented pattern and the finger prints produced by the thumb or finger in all possible positions and with all directions of pressure can be compared. The work must naturally be done on the near side of the vessel in order that the exterior can conveniently be seen. The most effective and comfortable position of the hand is with the fingers on the inside and the thumb on the outside of the vessel, the thumb being the active indenting agent; this is the method followed by modern Pueblo potters in welding coils.[1] A careful scrutiny of sherds discloses the fact that the same method was usually, although not invariably, followed in prehistoric times, for finger, rather than thumb, indentations are very rarely found on the exteriors. The possible comfortable positions of the thumb lie within an arc of 180 degrees between vertically upward and vertically downward, depending upon the height at which the pot is held. If the pot is on a table the vertical downward position is awkward, but with the pot in the lap or on the ground, that position is less unnatural. With the thumb directed upward, the vertical position is difficult because the fingers must be raised to avoid pressing against the edge of the vessel. When the thumb is pointing downward, either vertically or obliquely, the wrist must be raised and the arm is in an uncomfortable position. The most natural position is with the thumb directed obliquely upward. When making test pieces for comparative purposes, five positions were used—vertical and oblique, with thumb directed up and down; and horizontal. An angle of 45 degrees to the horizontal was used for the oblique position.

The coil can be pinched with either the side, ball or tip of the thumb. The side of the thumb is not only the most convenient and natural to use but also gives a narrower, neater indentation than either the tip or the ball. The latter makes such a wide impression that it was probably rarely, if ever, used. The width and direction of an indentation made with direct pressure, together with the finger prints, will generally show how the thumb was held. A series of trials covering these possibilities of position and pressure brings out several interesting facts and makes possible the identification of many prehistoric methods of work.[2] It will be found that with a given direction of coiling the same relief pattern is formed with the right thumb directed obliquely downward and the left thumb directed obliquely upward, but in the former the lines of the finger print are approximately horizontal and in the latter approximately vertical (fig. 309, *a*, *b*); therefore, the finger print, together with the direction of inclination, is important in determining which hand was used in indenting. Horizontal lines in a print indicate a downward position of the thumb, and the

[1] Guthe, 1925, p. 33, Pl. 14, *a*

[2] Dr. Harold Cummins of Tulane University Medical School, who is engaged in an intensive study of racial differences in finger-print patterns, confirmed the validity of this method of analyzing the technique of Indented Corrugated pottery and answered the query regarding possible confusion and error arising from individual differences in digital markings. In a personal communication Dr. Cummins states: "It appears that marginal portions of the digits were used in indenting the coils, and in these regions the alignments in different digits and individuals is fairly uniform, sufficiently so at least that you are not likely to be misled by this point." Dr. Cummins analyzed an Indented Corrugated sherd submitted to him and independently checked the conclusions reached by the experiments described.

inclination of the indentation shows whether the right or left thumb was used.[1] It will be found that the direction of pressure, as well as the position of the thumb, influences the angle of indentation. With the thumb, for example, in an oblique position in relation to the coil and pressure backward, the impression produced is nearly vertical, but if pressure is directly downward, the angle of indentation is distinctly oblique (fig. 309, *d*, *f*). Pressing downward with the edge of the thumb does not give the wavy coil edge which might be expected and which is made by pressing downward with the ball or tip of the thumb. Relief of the indentation is sharper, with both side and tip of the thumb, if pressure is toward the thick of the thumb rather than away from it. Either the tip or side of the thumb can be used without producing a nail mark. The fact that the thumb or finger often cannot be placed in the indentation of a sherd is explained by the backward pressure in indenting, which pushes a slight ridge of clay against the previous indentation, thus reducing its original size.

A thorough study of the technique of prehistoric indented pottery may show that of all the theoretically possible positions and degrees and directions of pressure only a few were widely used and that diversity of appearance was produced by variations in the texture and consistency of clay, size of coils, extent to which coils were flattened, and part of coil pinched. Certain techniques obviously have chronological or geographic significance. Naturally, all features of manipulation are more distinct and decisive in some sherds than in others. Lack of skill and carelessness also account for some irregular, uncertain patterns. The most convincing demonstration of craftsmanship in prehistoric vessels is in uniformity of indentation over the entire surface of a vessel, for not only must the pattern be preserved with different angles and curvatures, but if the pot is indented from the start, the coiling must be done in the opposite direction on the base from what it is on the sides and shoulders; for the base is started over a support or mould, is allowed to dry sufficiently to hold its weight without losing shape or marring the indentations, and is then turned over and the coiling continued in the opposite direction. The point where coiling was recommenced after turning the base can often be recognized, and it is of particular interest to compare the nature of the indentation above and below it. An excellent example of change in the type of indentation at the mould line is afforded by the jar illustrated in figure 271, *a*.

Measurements. A record of the evidences of workmanship should include measurements of width of coil, distance between indentations, depth of indentations (most easily measured with a depth caliper) and wherever possible the width of the vertical overlap of coils. The weld planes between coils can usually be found by repeated fracturing, and if the sloping surface at the fractured lap is looked upon

[1] The use of the left thumb for indenting does not necessarily indicate left-handedness, because in the oblique position with the thumb pointing upward it is as convenient and natural for a right-handed person to pinch with the left as with the right thumb. Also when indented corrugation is begun at the base and the same angle of indentation is maintained throughout, the opposite thumb from that used at the start must make the indentations after the pot is removed from the mould and inverted, unless the base is indented on the far side from the potter (see Dr. Kidder's discussion of methods of moulding corrugated vessels, p. 299).

as the hypotenuse of a right triangle then the other two sides of the triangle will be the thickness of the wall and the vertical length of the overlap. The latter is most simply measured by holding the sherd perpendicular to a plane surface, resting it on the acute angle edge of the fracture and placing a ruler parallel to the sherd on its fractured side. Overlaps vary somewhat in a single specimen with differences in curvature of the vessel wall. It is also interesting to calculate the diameter of the coil. When a coil is compressed by welding, its circular cross-section assumes the form of a parallelogram, the area of which is the product of the width of the exposed part of the coil and the thickness of the vessel wall. The area of this parallelogram is obviously also the area of the coil. The diameter of the original coil can, therefore, be simply found by dividing the area by π which gives the square of the radius of the coil. While this figure is convenient for comparing the diameters of coils of different types of corrugated ware, it is, of course, less than the diameter of the original coil because of the shrinkage of the clay in drying. As the average shrinkage of clays belonging to the class used for culinary ware is in the neighborhood of 10%, the calculated value may be taken as approximately nine-tenths of the original coil width.

On first thought some of these measurements may seem unnecessarily detailed and nonessential, but a record of workmanship is of little value for comparative purposes if given only in general descriptive terms, and these measurements actually indicate important facts regarding method; the distance between indentations, for example, is not influenced by the whim of the potter as much as by the way the thumb was placed and the direction of pressure when the coil was pinched. The depth of indentation often shows the degree of flattening of the coil, and the diameter of coils and amount of overlap may differ from period to period and therefore have chronological significance. It will be found that the habit of exact observation cultivated by recording of these measurements is invaluable, since impressions gained from a casual examination often lead to erroneous explanation of methods, and even the appearance of a ware may not correctly be described.

Consistency and plasticity of the clay. Something of the original consistency of the clay can be deduced from the surface texture of the fired vessel. An excessively sticky clay adheres to the fingers and is pulled up slightly when they are withdrawn, giving the surface a characteristic roughness. The distinctness of an imprint is also determined by the condition of the clay, and experiment will show the range in texture and consistency which will record a clear fingerprint. A highly plastic clay is necessary for fine coil technique. One simple means of testing the plasticity of clay is to roll up a small ball between the palms of the hands and then press it flat. The more plastic the clay the flatter the ball can be pressed without developing cracks. Practically the same thing is done when the roll of clay used in coiling is joined to the previous one; if the clay is not plastic the coil will crack along the lower edge. In Plain-surfaced ware these marks of a short clay are obliterated, but when coils are retained for decorative effect indications of the working quality of the clay are preserved.

The culinary pottery of Pecos and, for that matter, of the Upper Rio Grande in general, is not of outstandingly fine workmanship, yet the coil was treated in a

number of different ways and there is a clear chronological sequence of types. Although there are always some examples of careful, regular work, sherds chosen at random often give the impression that the potters did a good deal of experimenting without attaining skill in any method. In order to determine what, if any, technological distinctions exist between the various types of workmanship, stratigraphic material from Test D at Forked Lightning was examined microscopically, and the occurrence of the different types as determined by workmanship was plotted. Stratigraphic material from Test VI at Forked Lightning and Test XXI at Pecos was also studied, but in the former there were not enough sherds to warrant calculation of percentages and Test XXI revealed, with minor exceptions, a single method of manipulation.

The first significant fact brought out by the study of early Forked Lightning test material (Test D) is the chronological change in ratio of painted to culinary ware. Sherds of culinary ware make up 80% of the total sherds in the lowest cut but only 40% of those in the uppermost cut, and there is a comparatively steady decline from the one to the other. The proportion of culinary in Test VI sherds is extremely low (average 8% for the five lower cuts), except for Cut 1, and it is improbable that the true ratio for the period is represented. Culinary sherds average 29% of the total sherds in Pecos Text XXI, and there is no significant change in proportion during the period represented by this test.

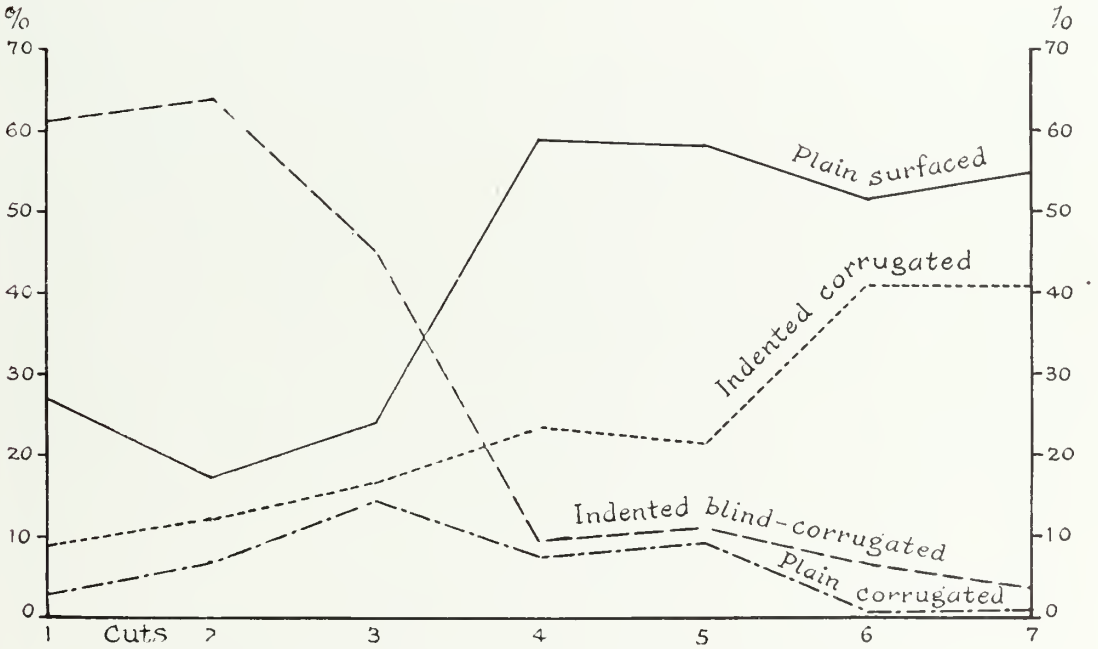
The occurrence of types of culinary ware in Test D is shown in Graph X. Plain-surfaced ware makes up over half the culinary sherds in the four lower cuts, then decreases abruptly to a quarter or less in the three upper cuts.[1]

In addition to Plain-surfaced ware there are three classes of corrugated ware: Unindented, Indented, and Indented Blind-corrugated.

Indented Corrugated, most abundant in the earliest cuts, is a variable type showing two principal methods of workmanship, which, for convenience, will be referred to as Right and Left Indented Corrugated. The two varieties are plotted as a single curve in Graph X. Left Indented Corrugated was coiled counterclockwise, and the middle or lower edge of the well flattened coil was indented with the side of the left thumb held obliquely upward and pressed slightly downward or backward (figs. 254, *i*, *k*, *l*, *m*; 255). Indentations are either irregularly placed or diagonal in arrangement, the latter effect having been produced by pressing each time at a point slightly in advance of the depression in the coil below, and always keeping the same

[1] Mr. Amsden (Vol. I, p. 29) suggested that the high percentage of plain culinary ware in the lower cuts of Test D might be explained by the occurrence in these cuts of thick, crude sherds, which possibly represent the work of the first comers to the site, who hurriedly made vessels for temporary use. However, such sherds are not sufficiently numerous to account for the great preponderance of Plain-surfaced culinary ware, and they appear to have been made by unskilled potters rather than hastily and carelessly made by experienced ones. Had they been intended only for temporary use while the settlement was being established, it seems improbable that they would have been found in all four cuts in slightly varying proportions, for consistent changes in the relative amount of both Black-on-white and culinary types show that these strata cover an appreciable period of time. The high proportion of Plain-surfaced culinary in the lower cuts may, therefore, be interpreted as evidence of lack of skill or unfamiliarity with the technique of corrugated wares on the part of at least some of the inhabitants of the village.

angle of inclination. Indentations are usually 0.95, rarely 1.25 cm., apart and vary in depth from 0.5 to 1.5 mm. Nail prints are exceptional. The width of coils is variable; in sherds from Cut 7, Test D, the average coil width is 0.6 cm. (approximately four coils to the inch) although finer coils (0.5 cm. in width or approximately five coils to the inch) are occasionally found. As time advanced coils were made slightly larger, the average width in sherds from Cut 4 being 0.7 cm. (3½ to the inch). Coils of a single specimen vary in width from 0.45 to 0.95 cm. Approximately a fifth of the specimens in the earliest cut have a vertical, rather than an oblique, indentation. Occasionally the upper edge, instead of the center of the coil, was indented, which gives it a slightly rounded contour. Left Indented Corrugated makes up approximately one-third of the total culinary sherds from the two lowest levels of Test D, but thereafter drops to a tenth or less, though it persists throughout Forked Lightning times and into the early Black-on-white period of Pecos.



Graph X. Test D, Forked Lightning. Techniques of Culinary ware.

Right Indented Corrugated, a variety of short duration and minor occurrence, appears coarse and carelessly made when compared with the previous variety. It differs from it in direction of coiling and method of indenting, being coiled clockwise and indented with the edge of the right thumb held in oblique upward position and with direct pressure (fig. 254 *f*, *g*, *h*, *j*). The coarse appearance is due partly to the greater width between indentation (1.25 instead of 0.95 cm.) which together with the gently sloping relief of the nearly symmetrical depressions indicates direct pressure. The indentations vary from 0.5 to 1.0 mm. in depth, being as deep as the majority

of those in Left Oblique specimens, which type, however, appears to have much greater relief because the depressions are closer and more abrupt. The indentations of Right Indented Corrugated are seldom regularly placed and hardly decorative in effect. The well flattened coils are of the same average width as those of contemporaneous Left Indented Corrugated (0.7 cm. or 3½ to the inch), but the vertical overlap is less (0.30 instead of 0.45 cm.). The average width of coils is surprisingly uniform, but variation from coil to coil in a single specimen is considerable, 0.45 to 1.90 cm. There seems to have been, therefore, less intentional variation in this than in the previous variety. A few examples of Right Indented Corrugated were found in Cut 6 of Test D, and at its height in Cut 4 it makes up 13% of the total culinary sherds, but disappears in Cut 1.

Indented Blind-corrugated is represented in the lowest cuts of Test D by only a few sherds, but becomes the preponderant type of corrugated ware by the middle of Forked Lightning times, and holds that position through the Black-on-white period of Pecos. The technique of this type is difficult to understand from the marks of workmanship which remain. The coils are so completely effaced that no overhang remains at the laps, and consequently it is at times impossible to tell which is the lower edge of the coil. There is besides considerable variability of workmanship, as well as chronological change in method of indenting. The one feature common to all examples of the type is the obliteration of lines between coils. A few specimens in the early levels have clearly been indented along the juncture of coils, and the theory that coil lines were pressed out in the indenting process seemed plausible, especially as test pieces made in this way resemble some examples of the type. But upon careful examination the majority of sherds appear to have been indented squarely across the middle of the coil, and pressure apparently did not extend over the lap, as evidenced by a slight, but distinct, ridge in this area. The line of coil junctures must, therefore, have been smoothed over either before or after indenting and the fact that edges of indentations are rarely smeared indicates that smoothing preceded indenting. Sherds which can properly be oriented (particularly rim sherds), and which have a distinct backward indentation, show that coiling was in a counterclockwise direction, though a few exceptions have been found. Indentations were made with the side of the thumb held upward and with either direct or backward pressure, also sometimes with a twisting motion. Nail imprints are very rare. The average width of coils, measured from ridges and faint traces of junctures, varies from 0.80 to 1.25 cm. (approximately three and two coils to the inch). The Forked Lightning coils average wider than the Pecos. The indentations of the former also suggest backward pressure, in contrast to the direct pinch which is characteristic of the Pecos types. The distance between indentation is from 0.80 to 0.95 cm., and their depth, 0.5 to 1.5 mm. Extreme specimens found in Test D of Forked Lightning have indentations of from 2.0 to 3.0 mm. in depth. While examples of extreme relief are found only in the early period, the difference in depth of indentation between typical early and late forms is not as great as it appears, the effect of depth being due principally to type of workmanship and the general relief pattern. Indentations are usually irregular in arrangement, but occasionally diagonal or vertical, especially in the early specimens of extreme relief. Horizontal ridges at the original coil laps are sometimes well

marked, but often there is no trace of corrugation, the surface evidently having been made practically plane before it was embellished by pushing up rough vertical or oblique ridges of clay. In some examples with clearly defined horizontal ridges, indentations were apparently not made until three or four coils had been laid and welded. The late form of the type as compared with the early has closer indentations which are made with direct pressure. Relief of indentations is not as great as between horizontal ridges and indentations. Coils were thoroughly welded and sherds can rarely be fractured along coil lines, but the few successful breaks indicate a vertical lap of 0.3 cm., less than the average for Indented Corrugated.

Indented Blind-corrugated types make up more than half the culinary sherds of middle Forked Lightning deposits (Cuts 1 and 2 of Test D), and the type is still preponderant in the three lowest cuts of Pecos Text XXI, reaching 84% of the total culinary sherds in Cut 9. It then drops abruptly to one-fifth in Cut 7, being replaced by a hand-finished type which shows no effort to obtain decorative effect by manipulation of the clay.

Unindented Corrugated, a variable type, is of rare occurrence at both Forked Lightning and Pecos, practically never exceeding 10% of total culinary sherds. Coiling was generally counterclockwise, but a few examples of clockwise coiling were also found. Examples from the lowest strata of Test D, Forked Lightning, have flat, broad coils, averaging 1.25 cm. in width (approximately two coils to the inch), which were but slightly lapped (0.16 to 0.32 cm.). By middle Forked Lightning times, a variety with narrower coils (0.7 to 0.6 cm. in width or three and one-half to four to the inch) is found which has a distinct "clapboard" effect (fig. 261, *g*, *j*, *l*). Still a third variety has a ribbed appearance, produced by pressing the upper part of the coil with the thumb held in a horizontal position. This method leaves a little roll along the lower edge of the coil (fig. 261, *b*, *d*, *e*). Width of coils in this subtype varies from 0.8 to 0.5 cm. (three to five coils to the inch), and the roll or unflattened part of the coils is from 2.0 to 4.0 mm. in width. The unflattened edge of the coil was often smoothed with a horizontal sweep of the fingers, for it is sometimes pushed slightly over the thumb print on the flattened part, is smooth, and shows the marks of the finger stroke.

The development and relationships of these diversified techniques is a matter of considerable interest. But since Pecos was dependent to a large extent upon the pueblos of the Upper Rio Grande area, problems of origin and derivation of Pecos types can more effectively be studied when the characteristics and history of the culinary pottery of the general region is better known. Plain-surfaced ware, coarse Unindented Corrugated and Right Indented Corrugated show less skill in workmanship than Left Indented Corrugated, and the latter group should be studied carefully for evidences of trade.

The study of painted wares has shown that types defined on the basis of surface features are also usually distinct in technological character. Consequently, such types are often as easily recognized by clay or tempering material as by finish or decoration. The various culinary types, which are defined by workmanship, cannot, however, often be distinguished by materials. Any plastic clay could be utilized as well for one manipulative technique as another, and color was not

important. Although several kinds of tempering material were used, sand tempering was the general practice and few close correlations have been found between kinds of temper and methods of workmanship. Thus, while there are important differences in pastes, they are of chronological or geographic significance and are seldom constant in the types defined by workmanship. There is, however, some relation between grain size of temper and finishing methods, for a coarse paste could be smoothed with the finger but not with a scraping tool. Intrusives are recognized in culinary as well as in non-culinary ware and are naturally of considerable interest and archaeological significance.

Culinary and non-culinary vessels differ in physical properties because of their distinct functions. Color and texture of paste are of little importance in a cooking-pot, since the surface is soon covered by soot, but it is necessary that the vessel stand sudden changes in temperature and that it conduct heat readily. Furthermore, for the specialized technique of corrugated ware, a plastic clay is desirable both in order to permit the rolling of small coils and to prevent cracking of the coils when pressed. Two properties characterize a large proportion of Pecos culinary ware: coarse-textured paste and thinness of vessel wall. The advantage of thin walls for rapid heating is obvious.[1] Moreover, an open, granular paste can be heated and cooled with less danger of cracking than a fine, dense, hard paste such as was used for some of the painted wares. It is not improbable that the potters discovered this fact through experience. Mechanical strength was evidently not a primary consideration, for culinary vessels, because of their thin walls and coarse friable paste, are easily broken. Strength was sacrificed to efficient heating.

Sand is the common tempering material of culinary wares from Forked Lightning and Pecos. Untempered paste, however, is found in sherds of Test D, particularly in the Plain-surfaced type of the early period, being present in 60.7% of these sherds from the earliest level, but decreasing gradually and steadily to 6% of such sherds in the uppermost cut. Untempered sherds are of sporadic occurrence in Indented Corrugated and exceptional in Indented Blind-corrugated types. There are two possible explanations for this fine-textured paste of Plain-surfaced ware—its advantage for finishing vessel surfaces and custom established by different peoples. A smooth surface is difficult to obtain, particularly with a tool, if the paste is coarse, because grains are pulled out and dragged along with the tool. Yet the untempered sherds do not seem to have come from well made vessels, for they are often crude in form and thick walled. It would seem more probable, therefore, that the untempered clay of the Plain-surfaced types and the coarsely tempered paste of the Indented types represent distinct customs, developed irrespective of considerations of ease of working; and it is even possible that the Indented vessels were at first obtained in trade, Plain-surfaced ware having been the work of native potters who had not yet learned the advantages of coarse temper and thin walls. In any event, untempered paste decreases with the decline of the Plain-surfaced types and does not reappear when non-corrugated wares (striated types) became abundant in the Pecos tests.

[1] A Cochiti potter explained the use of coarse sand temper in the same way, apparently thinking that heat passed through the clear grains more rapidly than through the clay. Whether this is an individual conception or a general idea among the Pueblos is not known.

Changes in texture of paste are correlated with finishing or smoothing methods. Large grains of sand mar a surface when it is finished with a scraping tool, but they do not seriously interfere with hand work and consequently indented vessels made from coarse-textured paste were smoothed on the inside by hand.[1] But when a type smoothed on the exterior with a tool which left fine striations (Faint-striated, see p. 319) was introduced, a medium or fine-textured paste replaced the coarse one used for Indented Blind-corrugated.

Mica is abundant in some of the sand-tempered types of Forked Lightning, but these should not be confused with a distinctive micaceous paste which occurs rarely in Forked Lightning but becomes common in the lower cuts of Pecos Test XXI, the levels in which Indented Blind-corrugated was at its height. The paste is distinguished by fractures of granite or gneiss and the numerous plates of muscovite and angular grains of quartz in the paste are clearly derived from the same rock (fig. 305,*f*). While it is possible that granite was ground for temper it is far more probable that this is a primary clay, the inclusions being rock remnants originally present in the clay making the addition of temper unnecessary. Clays of this class are frequently used by the modern Pueblos for cooking ware.[2] This type of clay is highly plastic, but there are few indications of lack of plasticity in any of the clays of Pecos culinary types. The surface texture of the micaceous Indented Blind-corrugated shows that the clay was more sticky than that of the other types.

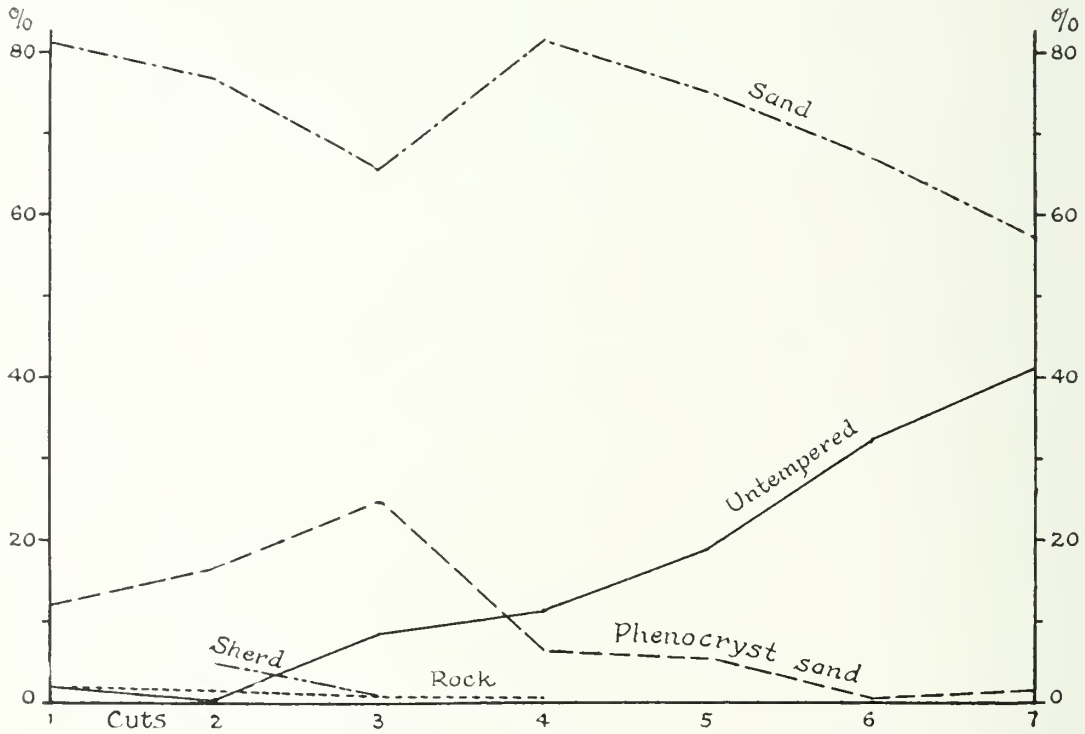
Sand-tempered sherds differ in the accessory minerals found in the paste and a detailed study may reveal distinct sources, but this work can be carried out most profitably together with the study of culinary pottery from the remainder of the area and the analysis of the sands of the various drainages. It has been necessary, for the present, to confine the study to the types which are very definitely of foreign origin. A few rock-tempered sherds are found in the four upper cuts of Test D, making up 0.4 to 2.0% of the total culinary wares of the respective cuts (Graph XI). The rock is invariably of the intermediate porphyritic type found on the west side of the Galisteo Basin, and since culinary pottery of the Galisteo pueblos was rock-tempered during this period there is no doubt, in view of the few examples found, that these sherds are from pots obtained in trade from those villages. Rock-tempered paste was found in Plain-surfaced ware, Indented Corrugated, and Indented Blind-corrugated. A few sherd-tempered specimens of all major types were found in Cuts 2 and 3 of Test D (4.8 and 0.6% respectively of total culinary). It would be natural to associate these with the sherd-tempered Black-on-white ware of the Galisteo Basin, but in the small lots of culinary sherds from that region which were examined, sherd temper was not found. It is significant that neither rock- nor sherd-tempered types are found in the lowest cuts of Test D, but appear in those upper levels in which Crackle type, the Galisteo Black-on-white ware, was just becoming established.

Sherds from intrusive culinary vessels of Pajaritan origin are found in all the

[1] The lines left by finger smoothing are shallower, more uniform in depth, closer and finer than tool-made striations. The fine striations left after smearing moist clay with the fingers are produced partly by the skin ridges and partly by small particles of dry clay which adhere to the fingers.

[2] Guthe, 1925, p. 22.

cuts of Test D and one occurrence was noted in Test XXI. The sherds are tempered with sand composed of phenocrysts from the rhyolite tuff of the Pajarito Plateau and are perhaps the most interesting and convincing of all the Upper Rio Grande trade wares found in Pecos or Forked Lightning. The phenocrysts include well formed, simple rhombohedral crystals of quartz and crystals of sanidine (fig. 306, *f*). These are both high temperature forms characteristic of extrusive rocks. Sands of the Pajarito Plateau glitter with such crystals weathered out from the tuff. The sand temper of the sherds is usually clearer and freer from tuff than sands in the



Graph XI. Test D. Forked Lightning. Tempering materials of Culinary ware

stream beds of the plateau and the large ant hills made up of this sand are a possible source for the tempering material in question. As Pecos potters would certainly not have made the long journey to the Pajarito Plateau for sand temper when unlimited amounts of equally good sand were to be had at their very door steps, this is unquestionably trade ware. With experience it can be recognized megascopically, for the clay did not adhere to the smooth crystal faces as it did to the rough, rounded grains of ordinary stream sand, and consequently crystals are often exposed on the inner surfaces of sherds. The grains are clear and vitreous in luster and there is a noticeable absence of opaque grains. With a binocular microscope crystal forms can plainly be seen and the quartz grains are characterized by liquid or gaseous inclu-

sions which appear as minute white specks in the otherwise clear crystals. All sherds from Tests D, VI, and XXI were carefully studied with the binocular microscope to determine the percentage of this type. It occurs in all four of the early culinary types, but is most abundant in Indented Blind-corrugated, and reaches its height in Cut 3 of Test D, in which it is found in 24.8% of all culinary sherds (Graph XI) and in 34.5% of the Indented Blind-corrugated sherds. It is also present in Test VI, but the proportions are not significant because of the few culinary sherds in this test. One sherd was found in Cut 10 of Test XXI, but none later. This large volume of trade in culinary vessels, which were bulky and fragile, was quite unsuspected and makes it much easier to credit to trade the large percentage of decorated vessels containing foreign temper which have come to light at Pecos.

It will be interesting to determine whether the eventual disappearance at Pecos of a type such as the Pajaritan culinary results from a change in trade relations or from the dying out of the type in the locality of its origin. The Pajaritan ware is most abundant during the period in which Forked Lightning was still under the dominance of the Santa Fe area and when Crackle Black-on-white was just appearing, and it is completely submerged by the micaceous primary clay paste subtype of the same type of workmanship at the time when the decorated ware of Pecos was almost entirely of the Crackle type. Whether this distinct primary clay paste is also due to Galisteo influence must be ascertained by studying culinary ware from Galisteo sites. It is not probable that the Galisteo villages, which had no near or convenient source of primary clay, could have contributed to the development of the type. The first logical place to seek its origin would undoubtedly be in the villages skirting the Sangre de Cristo Range, particularly those on the west side of the mountains.

With the decline of Indented Blind-corrugated, the primary clay became rare. Much of the succeeding ware has a peculiar and characteristic roughness evidently resulting from finger finish without careful, final smoothing. The paste is tempered with stream sand, and the same paste continued in use when striated types with tool-smoothed interiors replaced the hand-finished types.

The greatest number of distinct pastes as well as manipulative techniques is found in the Black-on-white period, recalling the variety in paste composition of the decorated wares of this horizon. The Black-on-white period appears, therefore, to have been a formative stage in which Pecos was influenced by, and to a certain extent dependent upon, the customs and standards of more centrally located Pueblos. By the time the striated ware replaced the corrugated types, pastes had become standardized and afterward changed mainly in texture as required by the smoothing process.

Fig. 305. Paste of Black-on-white and Culinary types.

Thin sections in ordinary light. Magnification 45 diameters.

a. Untempered Blue gray for comparison of grain size with that of other Black-on-white types illustrated. The white grains are mostly quartz, a few slightly grayed ones are feldspar. The dark object at the lower edge is part of a lump of unmixed clay. Numerous irregular grains of marl of the same size-range as the mineral inclusions are indistinguishable from the paste except in polarized light.

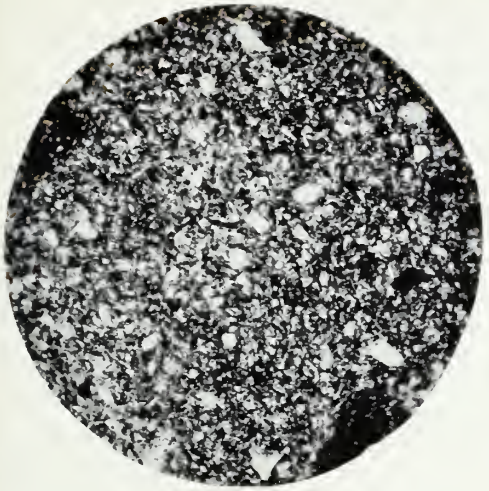
b. Crackle type Black-on-white. The large sharply defined irregular dark masses are fragments of sherd temper of different color and texture. Small dark particles of sherd may also be seen. The grains of quartz in the clay do not exceed in size those in the potsherd temper.

c. Crackle type Black-on-white paste containing a large black fragment of culinary potsherd temper with included igneous rock temper. The large whitish mineral bounded by crystal faces is a phenocryst of feldspar with a fragment of cryptocrystalline groundmass (gray) on the left side; other fragments of rock groundmass may be seen in this one piece of potsherd temper. A second smaller fragment of black sherd temper occurs just to the right of the large one. A difference in color and texture of clay base may be seen when this and the example of Crackle in *b* are compared with Blue gray in *a* and Rowe in *d* and *e*.

d. Sand-tempered paste of Rowe Black-on-white. The shape, grading and proportion of sand is typical. The larger grains are all quartz and with the exception of the one in the lower sector are classed as fine, and very fine following the proposed textural terms.

e. Paste of Rowe containing two fractures of fine sandstone with brownish calcareous cement. The clear grains are mainly quartz and the feldspar grains are indistinguishable from them in ordinary light except for one in the lower fracture which is grayed by alteration. At the lower right edge of the upper fragment is a free grain with cement adhering to it.

f. Primary clay of Plain culinary from full Glaze I Red levels. The long slender bundles on either edge are plates of muscovite viewed edgewise; flakes of muscovite may be seen to the right of the center and at either end of the upper bundle. The large grains are quartz.



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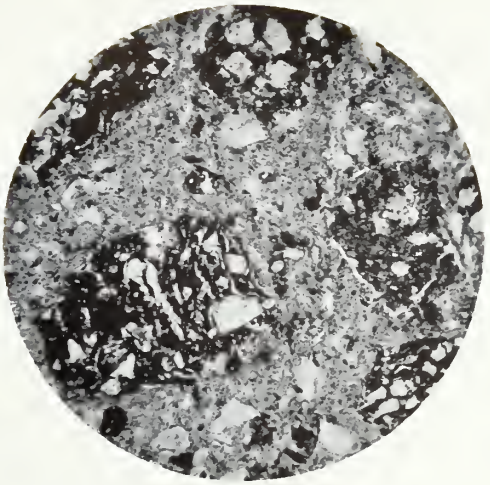

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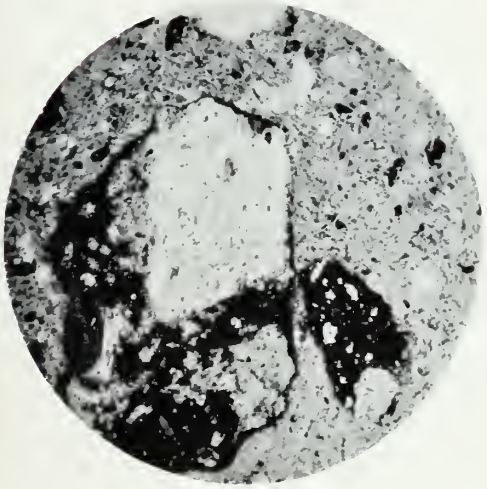

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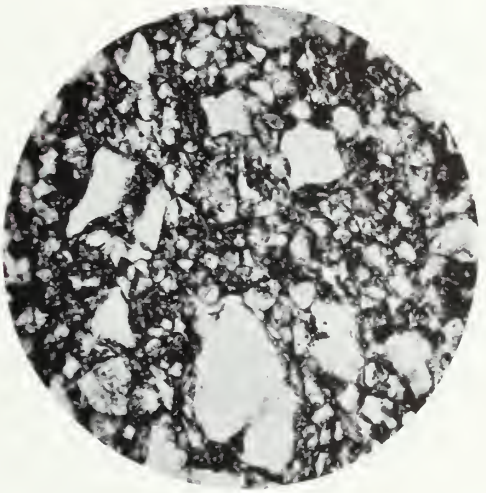

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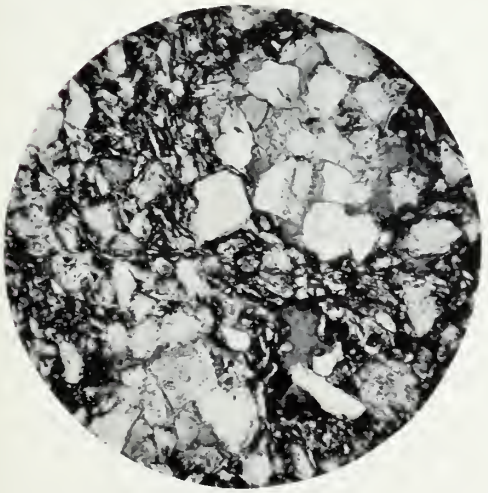

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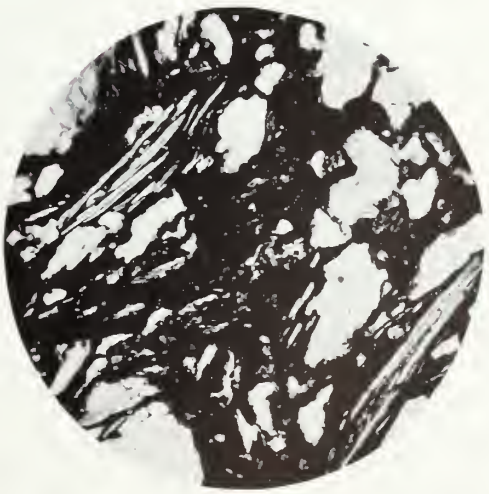

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Fig. 306. Tuff-tempered pastes.

Thin sections in ordinary light. Magnification 45 diameters unless otherwise indicated.

a. One of the commonest forms of tuff found in Black-on-white, Biscuit, and Modern wares. The specimen is Biscuit B. With the exception of a few of the very small grains and the two white areas on the right, all light colored patches are volcanic glass. Flowage lines may be seen on some of the larger flakes.

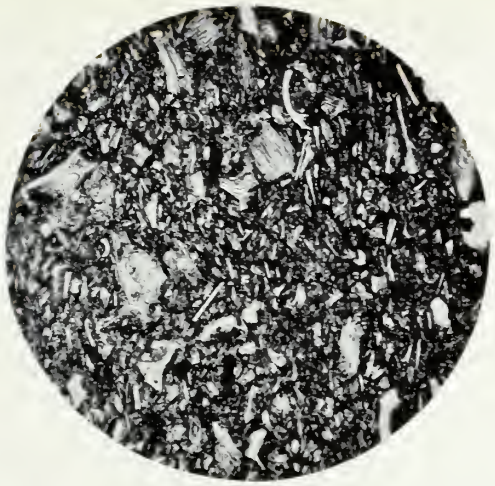
b. Biscuitoid paste containing large vesicular particle of tuff.

c. Biscuitoid paste showing orientation of platy tuff. Section cut parallel to the plane of the coil junctures. A few small clear fragments are quartz and there is a small prism of tourmaline, the remainder of the light colored material is tuff. Magnification 55 diameters.

d. Biscuitoid. Section cut from specimen illustrated in *c* and normal to the plane of that section, showing the plates in cross section. Magnification 55 diameters.

e. Late variant of Blue-gray Black-on-white. In the upper half of the section are three large particles of pumiceous tuff; the one on the right contains a slender dark prism of hornblende. In the lower half is a large fragment of corroded plagioclase.

f. Indented Blind-corrugated. The large fragment of quartz has distinct crystal boundaries and an irregular edge of glass. A few particles of tuff can be recognized by their form. The remainder of the larger clear fragments are quartz.



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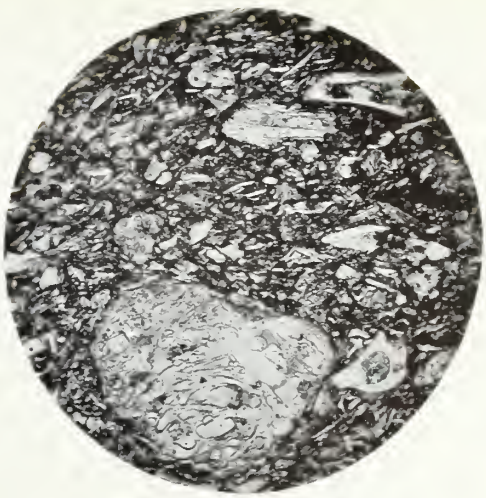

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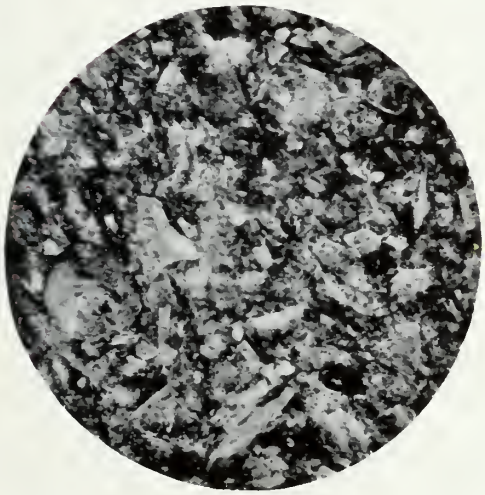

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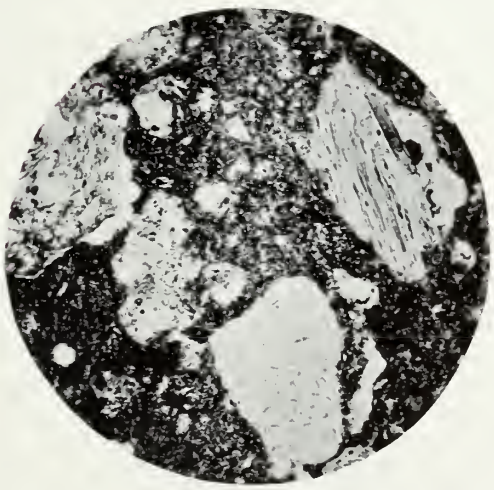

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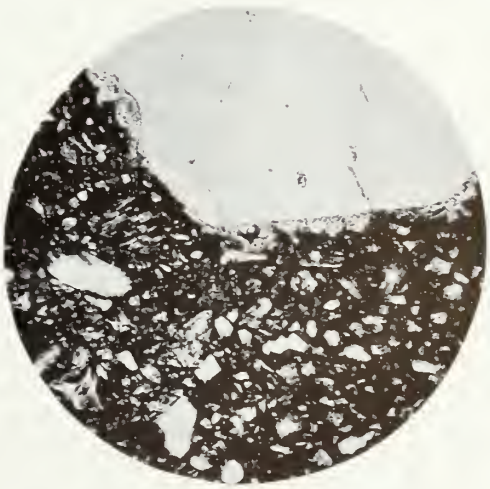

f

Fig. 307. Pastes of Glaze ware.

Thin sections in ordinary light. Magnification unless stated is 45 diameters.

a. Fragment of diorite in Glaze I Yellow. The large light colored mass is a rock fragment composed of much-altered andesine crystals, the boundaries of two of which may be seen in the lower left; just above these is a crystal of augite, imperfectly diamond shaped with cleavage lines and an inclusion of magnetite.

b. Augite andesite in Glaze I Red. The fragment on the right contains a phenocryst of plagioclase and on the left is a crystal of augite with an inclusion of magnetite. Magnification 67 diameters.

c. Hornblende andesite from volcanic breccia in Glaze VI. The white crystals are plagioclase, the dark patches resorbed hornblende.

d. Hornblende andesite from volcanic breccia, Arroyo Cuervo, for comparison with fragments in Glaze VI paste shown in *c*.

e. Large fragment of augite andesite in Glaze VI illustrating detail found in some rock fractures. The crystals are augite; the fracture of the one in the center must have been caused by movement of the magma before final solidification of the rock. The clear groundmass is composed largely of fine plagioclase crystals and the black patches are magnetite.

f. Siltstone temper in Glaze III. Free grains of quartz and feldspar are of the same shape and grading as in the rock fragments. The small dark patches are biotite.

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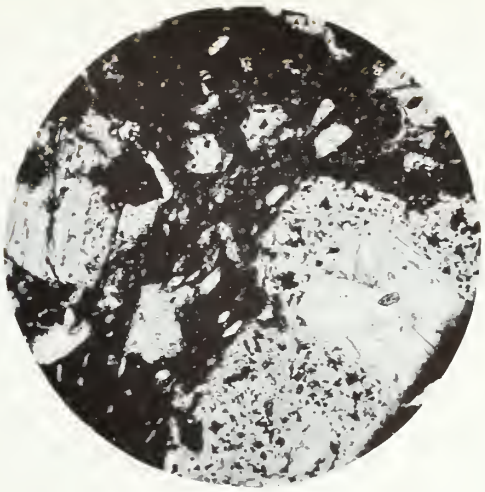

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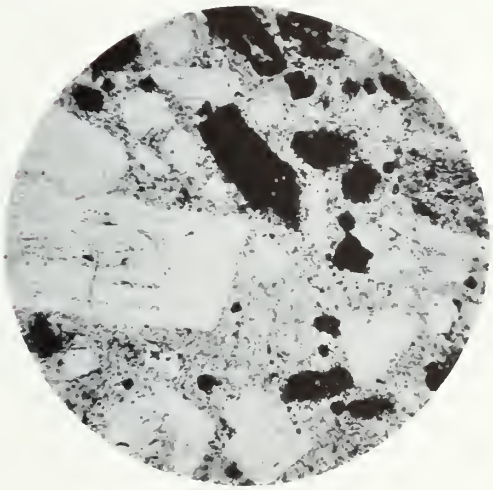

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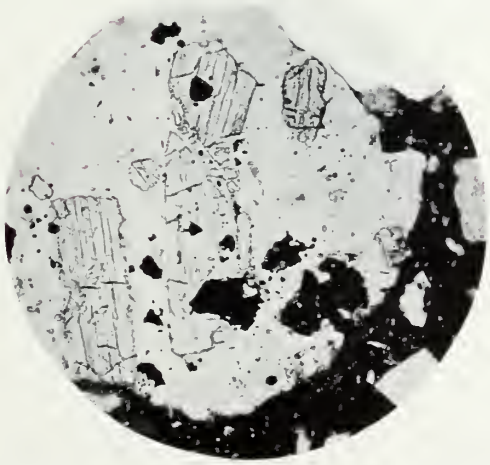

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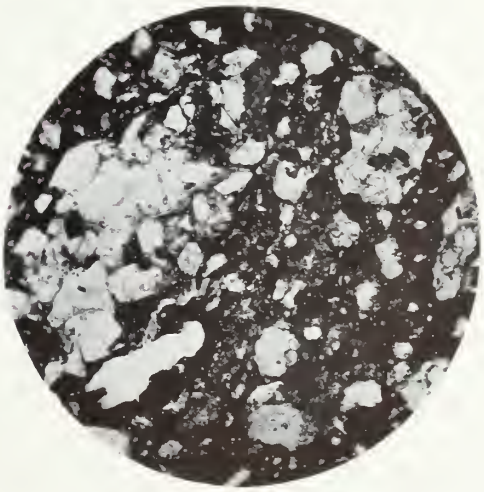

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Fig. 308. The glaze paints.

The photographs *a*, *b*, and *c* are thin sections in ordinary transmitted light, magnification 45 diameters; *d*, *e*, and *f* surfaces viewed in incident light, magnification 11 diameters.

a. Opaque glaze of Glaze I Red, the black outer layer. The glass cannot be seen because of the pigment held in suspension. The slip beneath is barely distinguishable from the paste but appears lighter and contains fewer mineral grains.

b. Glaze with patches of pigment, Glaze I Yellow. The glass is light brown with numerous bubbles and the opaque pigment has collected principally in the outer zone. Reaction of the glaze with the slip has left the line of contact hazy and indefinite. On the right the glaze has penetrated deeply into a branched pore or crack and a channel of glaze flows through two fragments of diorite in the lower center.

c Color zones in thick vitreous glaze, Glaze V. The outer layer is dark brown clouded by numerous angular inclusions; just beneath is a clear bright yellow glass which in turn blends into a green glass. The light gray area is the slip and the opaque section at the bottom is the paste. On the right the glaze has penetrated a pore. The clear particle on the left between the yellow and green zones is microcline.

d. Surface view of glaze honeycombed by broken blisters, Glaze I Red.

e. Surface view of glaze showing partial solution of light colored slip and exposure of dark paste beneath with a cloudy irregular boundary between slip and paste, Glaze V. The glaze is crazed and the whitish spots are groups of minute blisters.

f. Surface view of glaze showing clear glass with sharply defined patches of pigment, Glaze I Yellow.

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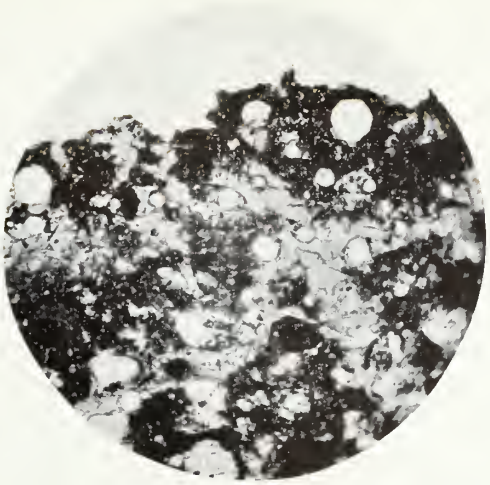

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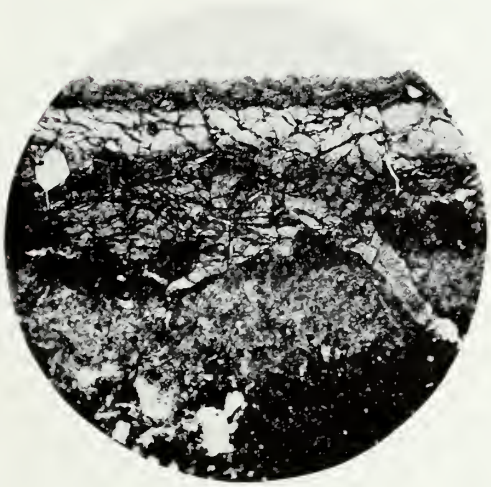

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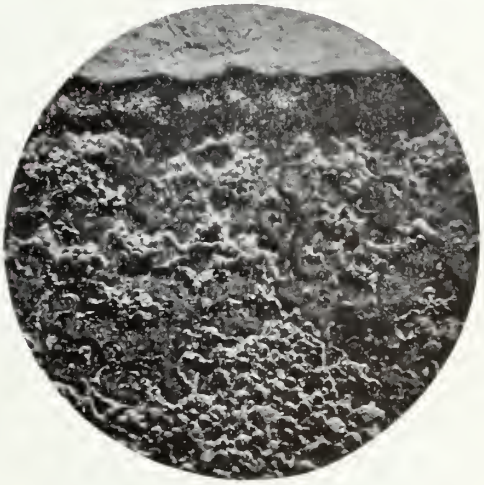

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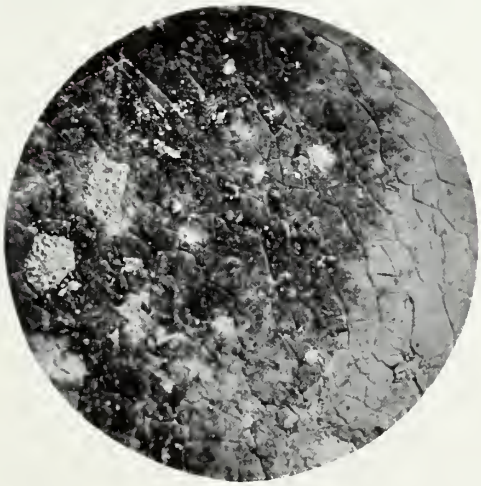

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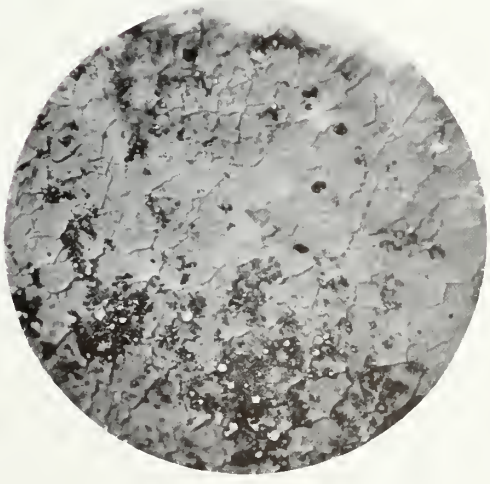

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Fig. 309. Technique of Indented Corrugated.

a. Counterclockwise coil indented with edge of left thumb in diagonal upward position.

b. Counterclockwise coil indented with edge of right thumb in diagonal downward position.

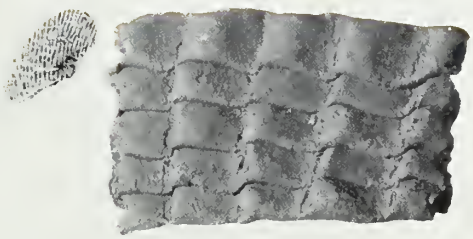
c. Counterclockwise coil indented with edge of right thumb in diagonal upward position and pushing away from the hand which produces the unusual deep nail marks and peculiar relief.

d. Clockwise coil indented with edge of right thumb, in diagonal upward position. Pinched with backward pressure.

e. Clockwise coil, indented with edge of right thumb held in diagonal upward position. Pinched with direct pressure on upper edge of the coil.

f. The same as *d* except that it was pinched with downward pressure.

g. The same as *e* except that it was pinched squarely against the center of coils instead of on their upper edge.



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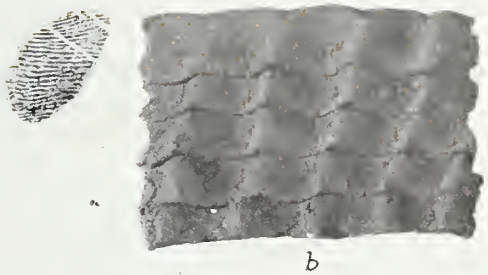

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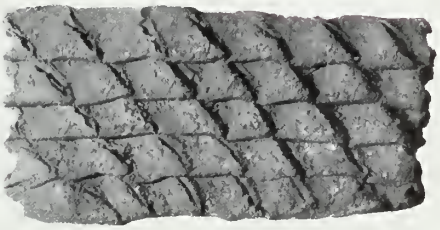

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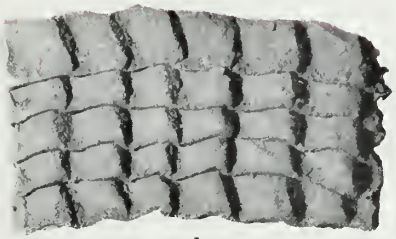

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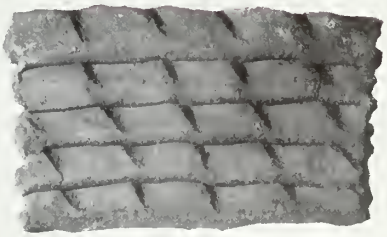

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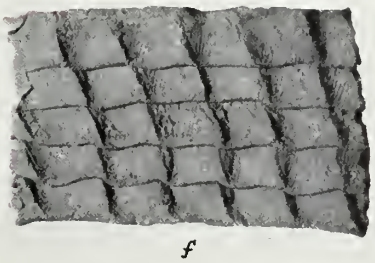

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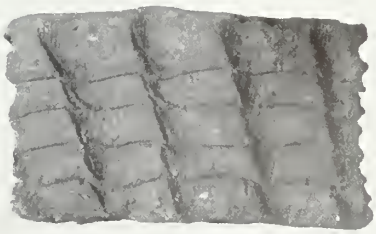

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CONCLUSIONS

There are two principal reasons for a technological study of pottery, as has earlier been mentioned: the first is to follow the history of the potters' craft, to learn if any progressive changes were made in strength and hardness of pastes, color and texture of slips, diversity and effectiveness of decorative mediums, and in the control and temperature of firing; the second is to study the evidences of trade relations and foreign influence through the identification of materials and the location of their sources. For both phases of such an investigation, Pecos offers an excellent opportunity because its long period of continuous occupation afforded ample time for normal modification as well as for varied foreign contacts, and because the many different geological formations of the Upper Rio Grande area greatly facilitate the investigation of original sources of clays and tempers.

Pecos is situated on a low eminence near the eastern base of Glorieta Mesa, a steep escarpment of Permian sediments. To the north and northwest is the Sangre de Cristo range made up largely of acid crystalline rock of Pre-Cambrian age. In the valley of the Pecos above the ruin are extensive exposures of Pennsylvanian limestone. The streams which drain these formations—the Pecos river east of the site and the Arroyo del Pueblo which skirts the Pecos ruin on the west—carry a variety of drift rock including granite, pegmatite, amphibolite, gneiss, mica schist, quartzite, limestone, sandstone, and shale. In the Permian sediments of the Pecos valley in the vicinity of the site are numerous outcrops of comparatively non-refractory, red-burning clays. The ceramic materials afforded by this environment are readily distinguishable from those of other parts of the Upper Rio Grande culture area.

Ceramically, Pecos was influenced most directly by the people of two adjacent regions in which the geological features are distinct. To the southwest was the Galisteo Basin separated from Pecos by Glorieta Mesa and bounded on the west by the Ortiz and San Pedro mountains. The intermediate igneous rock of these mountains and of the Cerrillos Hills to the north, is found nowhere else in the Upper Rio Grande area. Fragments of this rock in pottery, therefore, identify it with the Galisteo Pueblos. There are good quality buff-burning clays in the Cretaceous sediments of the Basin proper and these can be recognized in both the Black-on-white and Glaze pottery of the Galisteo villages.

The second center of influence, which for convenience has been called the Santa Fe province, lies in that section of the Rio Grande Valley which is northwest of Pecos and separated from it by the southern spur of the Sangre de Cristo mountains. Here the distinctive geological feature is the rhyolite tuff of the Jemez mountains, which form the western boundary of the province. Secondary deposits of this volcanic ash, either wind blown or water laid, are also found in the Tertiary sediments of the valley, and throughout this region tuff was commonly used by Pueblo potters for tempering material. Peculiar, highly adsorptive, bentonite-like clays, which burn to a peculiar drab color and fuse at low temperatures, are found in the northern part of the area. Biscuit ware, the typical decorated pottery which here superseded Black-on-white was made from these clays. Both tempering materials and clays from

the Santa Fe and Galisteo provinces serve therefore to identify the pottery in which they were used, and such pottery when found at Pecos furnishes a measure of the relative influences of these two centers.

The ceramic history of Pecos falls naturally into three periods determined by the character of the decorated ware. These divisions may be called the Black-on-white, the Glaze, and the Modern. The pottery of each period is distinguished not only by distinctive form and decoration but also by characteristic technological features resulting from the use of particular materials and the practice of fixed methods. In Black-on-white times the medium for design was an organic paint and slips were pale gray, the standard being a dark gray paint on a whitish background. Firing atmospheres were not strongly oxidizing and pastes as well as slips were usually gray. There was no attempt during these times to utilize the variety of buffs, reds and browns which can be obtained by firing ferruginous clays in an oxidizing atmosphere. The culinary pottery of the Black-on-white period has a variety of manipulative techniques by which artistic effects were achieved. This is particularly noticeable as the period advances, for in the earliest levels the percentage of culinary ware is high and the greater proportion of it is plain surfaced. The clays and the firing method of the Black-on-white period combine to produce a monotonous uniformity in color, with few contrasts; yet a variety of pastes are found (untempered clay and tuff-, potsherd-, sand-, and sandstone-tempered pastes), and clay with the properties of common brick clay occurs contemporaneously with clays suitable for terra cotta. This variety of materials is probably to be explained by trade and outside influence rather than by versatility or experimentation on the part of Pecos potters. The differences in hardness and color of pastes are undoubtedly due to the peculiar properties of clay from different deposits and are not evidence of intentional selection or better firing. There is no indication of change in firing temperatures or methods. In fact the kind of paint used on decorated wares imposed definite limitations upon firing treatment. It has been shown that the color of organic paint is due not alone to firing temperature and atmosphere but also to the degree of adsorptiveness of the clay upon which it is applied. Many sedimentary clays low in colloidal material do not hold or protect organic pigment, and short firing with slight draft is necessary to avoid completely burning out the organic matter.

The Black-on-white period at Pecos seems to have been a formative stage in which both the Santa Fe and Galisteo provinces contributed very largely to the ceramic standards and traditions. In the earliest levels at Forked Lightning, which represent the beginning of the Black-on-white period at the Pecos site, the high proportion of crudely made, undecorated vessels suggests the work of unskilled potters, perhaps the first settlers, at a time before trade relations were established. In early Forked Lightning times, represented by Test D, the style of decorated pottery was influenced mainly by the Santa Fe area, and pastes were variable. It will not, however, be possible to determine what proportion of the pottery was actually obtained in trade until the Santa Fe types have been more thoroughly and systematically studied. The tuff-tempered sherds of Blue-gray type, 15% to 20% of the total decorated ware, are most logically explained as trade pieces; and it is possible that part of the untempered Blue-gray pottery was also imported, since the Blue-gray sherds

of some of the valley sites of the Santa Fe area are untempered. The sherd-tempered Crackle type indicating Galisteo influence does not become important until middle Forked Lightning times and in the late Forked Lightning period it supersedes Blue-gray, becoming the dominant type. This pottery is not entirely the result of an attempt by Pecos potters to imitate Galisteo style. The presence of Galisteo culinary potsherds, used as temper in some Crackle type specimens, proves that they are trade ware because the Galisteo culinary ware of this period, distinguished by igneous rock temper is very rare at Pecos, only a very few sherds having been found. The dense, whitish paste typical of Crackle, which burns buff under oxidizing conditions and is of Galisteo origin, increases the probability that a considerable proportion of Crackle type is the result of trade. Crackle reached its height near the beginning of the settlement of Pecos, perhaps at a time when the energy of the people was directed to the establishment of the new settlement and the potters' art was neglected. As Crackle later declines, new tuff-tempered types from the Santa Fe area become prominent. The Rowe type, the only development of Black-on-white which appears to have been of local origin, has a coarse, friable paste, soft slip and poor finish, though an attempt at elaboration is shown by the flaring rim.

Although study of the Black-on-white pottery of Pecos suggests that intercourse was first principally with the Santa Fe area, then with the Galisteo and finally again with the Santa Fe, periods of influence may not be as sharply defined as they appear. The indications from surface survey are that during the time of Early Forked Lightning occupation Blue-gray was the principal decorated type of the Galisteo as well as the Santa Fe region, but an indigenous Galisteo Blue-gray has not yet been identified by technological features. In the beginning, therefore, Pecos may have been equally subject to these two regions, but with later specialization and the restriction of the Mesa Verde-like Crackle type to the area centering in the Galisteo, specific sources of influence are no longer open to doubt. Contacts should not be judged by painted pottery alone, and since most of the culinary ware is sand tempered, detailed study of the accessory minerals of the various drainages will be necessary to complete the investigation of this category. But the considerable number of culinary vessels tempered with the very distinctive sand of the Pajarito Plateau shows that there was much more trade in such ware than would have been suspected. This type seems to have been obtained in greatest quantity at a time when Blue-gray was still the principal decorated type and when Crackle was just beginning to be introduced. The cooking ware made of primary clay, which is found in the period in which Crackle was at the height of its development, should be studied more fully and its distribution traced.

The second period of Pecos ceramic history is marked by a great innovation, the introduction of glaze paint, and along with it the use of ferruginous clays for slip and, shortly afterward, for paint. The maintenance of an oxidizing atmosphere which had been unnecessary and in some instances undesirable in the previous period, now became important. Matte organic paint apparently went out of local use, being represented at Pecos only by intrusive Biscuit ware. The manipulative technique for culinary ware became simplified, plain or striated ware largely replacing indented. Glaze decorated ware apparently completely dominated the interest of the

potters of these times. It offers the best opportunity to study the evolution of a ware because, after the technique was once learned, Pecos achieved its greatest ceramic independence and made for a long period most of its own decorated ware. The pottery of this period is particularly worthy of thorough and systematic investigation since it records the history of the introduction and establishment of a distinctly new technique; it reveals the mistakes and failure of beginners, and the changes and developments which took place when the art was once learned. Intrusive and indigenous specimens at Pecos can be distinguished by technological evidence, and this data, correlated with chronological information, will give some idea of how long it took for a people to learn the use of totally new materials and methods. The first Glaze type, Glaze I Red, was more showy and attractive than the dull Black-on-white ware, and it is not surprising that it soon completely replaced the latter. All evidence points to the introduction of Glaze ware by way of the Galisteo pueblos, but the sherds from the lowest stratigraphic levels in which the type is found include many with basalt temper of the sort occurring in the Glaze ware made in pueblos bordering the Rio Grande from La Bajada south. Rock temper from the intrusive formation on the west side of the Galisteo Basin soon becomes characteristic. The difficulty and uncertainty of producing glaze, scarcity of good red slip clay, and inexperience in firing with oxidizing atmosphere, as well as possible secrecy as to the source of glaze material on the part of Galisteo potters, may account for the long period during which Glazes I Red and I Yellow were evidently obtained in trade. The other decorated ware of the period, Biscuit, was also unquestionably a trade ware, as is evidenced by its exceptional clay base and tuff temper. During the Glaze I period, therefore, Pecos potters had apparently ceased to make decorated ware, so much did they favor the new types, which lack of material and inexperience discouraged them from imitating. Local Glaze I Red has all the characteristics of beginners' efforts. The paste is sand tempered and the clay red burning, though relatively refractory, like many other Pecos pastes. The red slip was not permanent and the firing was generally too low to flux the glaze; consequently, slip was usually worn and the dull, granular, lusterless glaze paint often flaked off with the slip—all failures natural for potters unfamiliar with the materials and methods required for a new type. By Glaze II times, Pecos potters seem to have mastered the technique of making glaze pottery, and the period of Pecos' greatest ceramic independence opens. Some pottery, however, continued to be obtained from the Galisteo pueblos, the proportion in unselected lots averaging consistently between 6% and 8% of Glaze ware during Glaze II, III, and IV times. Biscuit ware also continued to be imported, making up approximately the same percentage of total decorated ware as did the imported Glazes. Pecos potters apparently never tried to imitate Biscuit; they realized possibly that they lacked the necessary materials, and in addition this pottery could hardly have had the same appeal as did the Glaze ware. Although they were making most of their decorated ware with their own clay and following the custom of earlier times of tempering the paste with powdered siltstone, they still observed the standard of finish and decoration of the Galisteo pueblos. Glaze IV shows the greatest refinement in texture of paste and hardness and color of slips, yet the percentage of intrusives is no higher than in Glazes II and III, and comparison of slip

color and texture suggests that slip clays which produced particularly pleasing colors were obtained from the same beds as used by Galisteo potters. Glaze V, the type which represents Pecos' one really unique contribution to the Glaze series, has a coarser paste; slips are limited in color range and the decorative effect of the glaze, whether intentional or unintentional, is due to luster and color more than to pattern. No foreign temper was found in any sherd of Glaze V type; furthermore, sherds of this type found in Galisteo sites are sand tempered, in contrast to the rock temper of all other Galisteo glazes. Glaze VI seems to have been largely if not entirely imported since the majority of sherds are rock tempered, a few exceptional ones containing a distinctive sand or sherd temper. Pecos potters may have been so well satisfied with the type which they themselves had developed that they never attempted to imitate Glaze VI but, although the two types were at first contemporaneous, Glaze VI persisted longer than Glaze V and the use of glaze paint must have been discontinued at Pecos sooner than at some of the other pueblos. During the long period in which Glaze pottery was locally made, there is little evidence of technological change, the same type of clay and temper being adhered to throughout. Firing methods, too, do not seem to have been modified. Potters would learn than an oxidizing atmosphere was necessary to produce good color and that certain temperatures were required to flux the glaze. As long as satisfactory results were obtained there was no reason to change. A variety of slip clays was known; some, used infrequently, were too soft to wear well and the color range was greater in some periods than others, but the principal variation was in the glaze itself. There were distinct differences in composition and pigment as the period advanced; whether they hold for the other pueblos of the region and whether they were intentional are two of the many interesting questions which await future investigation.

Culinary pottery of the Glaze period was practically all sand tempered and although more detailed study will be necessary to learn whether any was imported, the fact that, after Glaze I, Pecos produced most of its own decorated pottery makes it seem unlikely that culinary vessels were obtained from the outside.

The Modern period is marked by the disappearance of glaze and the return to a vegetable extract for paint, but the use of ferruginous clay learned during Glaze times was not forgotten and both red slip and red paint were employed, giving the ware more color and interest as compared with the matte paint wares of Black-on-white times. Successful firing of ferruginous clays necessitated an oxidizing atmosphere, but in spite of this fact an effective black was obtained with organic pigment because a highly adsorptive slip clay similar to that of Biscuit ware was known. Paste and slip colors border on the buffs and creams instead of the grays of Black-on-white pottery, which change further enlivens the character of the ware. The Modern period is also characterized by greater attention to the finish of vessels, and the nonculinary types include, in addition to the Painted ware, Plain Red and Plain Black wares, some examples of which are well polished. There was increased control of firing, for not only were wares requiring a good draft produced but a black ware was made by smudging the fire, the first appearance of this technique at Pecos. With these changes in style and ceramic practice the pottery of Pecos again shows the influence of neighboring pueblos, this time those of the Santa Fe area. Most of the painted

ware is tuff tempered, and that made with Pecos clay and sand temper is poorer in workmanshp and execution of design, though the slip has the same properties as that of the tuff-tempered subtype, and is also similar to the slip used at the present time by Santo Domingo and Cochiti potters. Body clay and tempering material are generally obtained from the nearest convenient source by modern Pueblo potters and our evidence indicates that the same condition prevailed in prehistoric times. Slip clays of good color and texture are not common, however, nor are they required in large quantities. Pueblo potters today obtain some in trade and go considerable distances for others. The slip of indigenous Modern Painted ware is in all probability therefore of foreign derivation, as this type of clay has not been located in the Pecos Valley. Both Plain Red and Plain Black wares are in part tuff-tempered and in the majority of cases the specimens with coarser-textured, sand-tempered paste are not as well finished as those made of the fine, light tuff-tempered paste. As stratigraphic material from the Modern horizon was not obtained, the proportion of tuff- and sand-tempered varieties could be determined only in sherds from general digging. It is therefore not possible to say whether, upon first appearance of these types, tuff-tempered specimens were more abundant, as would be expected had the techniques involved been introduced from the Santa Fe area. There are, nevertheless, clear indications that Pecos was again dependent upon the standards and methods of neighbors and that a period of decline in the art had set in.

There is no evidence that Pecos made the contribution to the ceramic development of the Upper Rio Grande area which might be expected of one of the largest and most flourishing settlements of the region. There were important changes during the history of the pueblo, in materials, workmanship and methods of firing, as well as in form and style of decoration, yet the Pecos potters seem very rarely to have initiated new methods or styles, nor are there striking examples of gradual independent improvement. In every period, they were influenced by and, to a certain extent, dependent upon the ceramic practices of neighboring pueblos, and material, technique and artistic standards were often directly borrowed or copied. Distinctly new methods were taken over slowly and in some cases only after the pottery had been obtained in trade for generations.

The interpretation which has been given to results of the technological study, presents a very different picture than would be formed by consideration of surface features alone. A large volume of trade and dependence of Pecos upon the more centrally located villages was hardly expected and such a conclusion is difficult to accept in view of the generally prevalent concept of the pueblos as independent economic units. The findings suggest a degree of specialization and industrialization which had not been anticipated. It is possible that the proportion of trade ware at Pecos is not representative of what would be found in more centrally located pueblos. Pecos, in its peripheral position, was in contact with Indians of the Plains and may, therefore, have been one of the chief trading centers of its time. But the pottery of Pecos must ultimately be studied in relation to that of the whole Upper Rio Grande area and local problems will not satisfactorily be solved until the pottery of the entire region has been thoroughly analyzed.

The theory that pottery from Pecos which contains foreign material is trade

ware has been advanced repeatedly and boldly throughout this discussion. In some instances the nature of the evidence is such that the interpretation will hardly be questioned; on the other hand in many cases it is fully realized and freely admitted that the data are not conclusive; we have not yet proven whether the raw material or the finished product was brought into the pueblo. In the light of our present knowledge it seems more probable that vessels were imported than that clays and temper were obtained from great distances and, since the former theory challenges present concepts, emphasis upon it may prove more stimulating than the mere statement of the problem. Actually however the results of the Pecos study should be considered as formulating problems relating to the ceramic development of the Rio Grande area and its historical and sociological implications which cannot finally be answered by the study of this one site alone. These questions may briefly be outlined:

1. Are conditions found at Pecos representative of the entire Upper Rio Grande area? Is there in all sites a large proportion of pottery containing material not found in the immediate environment, or are there villages or groups of villages where the bulk of pottery is made from clay and temper of local origin, with other settlements of contemporaneous occupation having a variety of subtypes marked by material from distant deposits? Such a situation would be expected had there been centers of pottery making with outlying dependent villages where the art was neglected. The fact that in some parts of the area a single class of tempering material varies even within short distances, greatly increases the possibility of ascertaining the actual extent of exchange in pottery of a single type among people of neighboring settlements. The Glaze pottery of the Galisteo pueblos, for example, seems to have been entirely rock tempered, yet there are recognizable differences in the particular variety of igneous rock most easily accessible to certain of the villages. Petrographic examination of a limited number of sherds from the surface has shown many variations although the rock in any given sherd is of uniform character. A study of carefully excavated material from the most promising sites may reveal some meaning in these variations.

2. Is there any evidence that differences in technique are due to a mingling of peoples; in other words, do subtypes represent the work of a foreign element resident in the village? Such a condition might be shown by the segregation of a subtype in some one section of a site, if remaining sections were contemporaneously occupied. This possibility should be considered in studying the association of untempered and tuff-tempered Blue-gray Black-on-white in valley sites of the Rio Grande. Ordinarily the people of a village would not be expected to use simultaneously different techniques to produce the same style of pottery. Were the people of the Pajarito Plateau possibly the first to use tuff temper and did clans from this area join the valley people, thus introducing the practice, or persisting in it, without affecting local custom? Both chronological and geographic distributions of the tuff-tempered and untempered Blue-gray subtypes will have to be traced in detail.

The possibility of the amalgamation of peoples who continued to follow distinct ceramic techniques is also suggested by the occurrence in some sites of Biscuit and Glaze in nearly equal percentages. This problem was defined by Dr. Kidder a num-

ber of years ago.[1] The style of these two wares as well as the technique is radically different and not only must origins have been distinct, but there are few if any evidences of influence of one upon the other. Is each made from clay and temper obtainable in the vicinity of the sites where both occur? If so, or if one was made from foreign material at the start, with subsequent change to local sources, then there can be little doubt of manufacture at the site. But if the materials of one are from a distant deposit, the question still remains whether the pottery was obtained in trade by a homogeneous people or whether a distant source of supply was being used, possibly by members of a group which had migrated from that region. Only the discovery of potters caches in excavation will prove importation of material. Although a mixed as well as a homogeneous people might use material from either a near or a distant source, petrographic analysis gives promise at least of showing whether trade must be considered as an explanation of this situation. It is not certain that the problem of whether a distinct pottery type is due to infusion of a new stock, or whether it is the result of slavish copying of an introduced technique and style can ever be subject to proof. But systematic study may at least suggest probabilities, or even some means of investigation not now recognized.

3. Is there a marked increase in the variety of ceramic materials in sites belonging to transitional periods, as compared with that in sites occupied when styles had become standardized? Are variations in technique discernable which may be attributed to foreign influences, or to stages of experimentation accompanying the introduction or development of new styles? Is, for example, early Blue-gray more variable than the fully developed type, or than specialized Crackle? Does Glaze I contain a greater variety of tempers than Glaze III or IV? Such in general is the case at Pecos, but these potters, as compared with those of centrally located villages, may have been less independent, more prone to adopt than to adapt.

4. Are there indications of changes in trade relations during the occupation of the Rio Grande area? Does the abrupt appearance and short duration of the subtype of Blue-gray tempered with coarse pumiceous tuff in Pecos Test XXI mark a change in contacts, or simply a limited period of production for this subtype? Its distribution and chronological relations should throw some light on the question. Is the replacement at Pecos of culinary ware tempered with Pajaritan sand by culinary made from primary clay due to shifting trade relations, or was there a change in technique throughout the region?

5. What is the technological history of the principal wares of the Upper Rio Grande area? Some problems have already been suggested in the discussion of the technological data. Interest naturally centers about the origin of types, though local modifications and developments may be equally important historically. The changes which accompanied the development of Blue-gray have still to be traced. The painted ware which preceded this type resembles Chaco Pueblo II stylistically, it is sherd termpered and decorated with mineral pigment.[2] Organic pigment may have been directly or indirectly introduced from the San Juan area, but a San Juan proto-

[1] 1915, pp. 459-460.

[2] Note by A.V.K.: This is perhaps Mera's Kwahe'e Black-on-white (1935, pp. 5-6).

type for the tuff-tempered and untempered paste of Blue-gray is not known, and these characteristics would seem to be strictly local developments due to the peculiar materials afforded by this particular region. Was organic paint first used on a paste essentially that of the Chaco-like type, or did changes in paste accompany introduction of the new pigment?

Specialized Crackle resembles Mesa Verde Black-on-white technologically as well as stylistically. It reintroduced the practice of using sherd temper, and its clay is more closely related to the Mesa Verde clay than is that which was generally used for Blue-gray type. Was this class of clay first used by the potters who introduced Crackle or has its earlier use been overlooked, because it is disguised by different firing? In other words, was the selection of a particular kind of clay an important feature of the ceramic tradition brought in with Crackle ware? Did the style and general technique of Crackle spread beyond the range of these clays, resulting in pottery having the appearance of poorly made Crackle? And if so, was it limited to a late stage when standards were weakening?

The relation of Biscuitoid and Biscuit presents an interesting problem in which the detailed study of clay should yield important information. Did experimentation with Biscuit clay precede the development of the Biscuit style? Were common sedimentary clays readily accessible to the pueblos where Biscuit was made?

Glaze ware offers one of the best defined fields for studying the introduction and development of a specific technique. The possible effect of contact with Little Colorado people, who made the discovery first, has been discussed in the section on Glaze. Sites in the vicinity of Albuquerque in the direct line of trade with the Little Colorado settlements, and which clearly show the influence of that region, should yield significant data.

Many of the above questions may appear to the general archaeologist to involve more time and more minute study than they are worth. But broader problems of the origin and development of pottery types, of the degree of specialization among pottery making people and of their interrelations, cannot satisfactorily be answered without exact and systematic studies, not only of technological features, but likewise of design, form, and workmanship. The Upper Rio Grande area is a very promising field for detailed research as to sources of ceramic materials and their historical significance because of the fact that rhyolite tuff, fine grained and prophyritic rocks of intermediate composition, and basalt were all important tempering materials; and because the distribution of each, which has some correspondence with centers of population, is well known, and varieties in each formation define even more restricted areas. The problem is not a simple one, as factors of trade, migration, slavish imitation of introduced techniques, and independent experimentation were probably all operative at one time or another. And further to baffle the investigator searching for readily classifiable types are technological accidents and the results of individual caprice. The archaeological questions here suggested cannot be answered by study of material gathered by surface sherd surveys. Fully reliable results must depend upon systematic technological examination of stratigraphic material from key sites. The research must inevitably be long and arduous. Nevertheless, as properly documented specimens become available and are studied, fundamental data will

accrue as to the occurrence of subtypes containing ingredients, the sources of which are traceable. And each bit of conscientious, accurate work, carried out with clear recognition of ultimate aims, will not only contribute to the final solution of our problems, but will reveal new methods of approach and new aspects of the whole historical picture.

It may reasonably be asked at this point which of the methods of analysis employed have been most fruitful of results; which, if any, have not justified the time they required. Petrographic examination is beyond question indispensable for the identification of temper and clay, for quantitative determination of texture, and for recovery of the mineralogical record of firing temperature. The most important data in the present investigation have been derived from the study of tempering material. The entire question of trade in pottery, undoubtedly the most significant result of the work, hinges on such identifications, which can be made only with the petrographic microscope. The possible value of the analysis of matte pigments is not well illustrated by the results from Pecos, since they are there limited to plant extracts and ferruginous clays. But the questions raised in the study of glaze paint give some hint of the evidence which may be preserved by decorative mediums and of the importance of quantitative chemical analysis and synthetic tests. Distinctive pigments as well as clays or tempers may be traceable to their source and contacts thus revealed by exact identification. Clays have most satisfactorily been defined by their firing behavior as well as, in some instances, by optical properties. The color, hardness, and porosity of the paste, when refired under controlled conditions, proved to be valuable criteria, and furnished bases for comparison, when due correction was made for the kind and amount of temper. Thus, for the majority of pastes red-burning clays were used, but certain buff-burning ones have also been recognized. These are found only in types which, judged by character of temper and stylistic features, center in the Galisteo basin; and this particular kind of clay occurs in that region, but has not been discovered in other parts of the area. The red-burning clays differ in refractoriness, and the relatively non-refractory ones are consistently tempered with sand or sandstone identical with those which are abundant in the vicinity of Pecos. Low refractive index distinguished Biscuit clay and the slip of Modern Painted ware, thus providing clues to their origin.

The physical properties of the wares reflect methods of manufacture rather than provenience of specimens. For this reason their study yields less definite archaeological information than does the identification of ingredients. Minor differences in the wares are shown, but usually the variation and overlapping between types is so great that no single property can be considered a reliable criterion for classification. This is to be expected, since the physical properties are directly affected by lack of standardization in the potter's methods, her impure materials, her guesswork mixing, and uncertain firing. For purposes of general classification color and texture are most useful. Although the same color is often found in many types, certain colors may be distinctive. Color also gives some idea of the character of the firing atmosphere. Transverse breaking strength has, in the present study, shown no important differences between types. Hardness and porosity exhibit very marked overlapping of types, yet a few significant differences in averages have been found. Greater dif-

ferences might be expected were wares of widely separated areas compared. In considering the significance of these properties it should be remembered that they measure not one but several inevitably variable factors. Although not definitive in themselves, they help to complete our picture of methods and characteristics, and may in some fields be of more value than at Pecos.

The results of the Pecos study substantiate the statement previously made that ceramic technology is not primarily a tool for the systematist, but rather a means of gaining a better understanding of the actual meaning of ceramic properties and so extending the usefulness of pottery in the interpretation of archaeological data. No important changes in classification have been suggested by the technological examination of Pecos pottery, although quite different explanations of origin and relationships of a number of types have been given, and new aspects of the problem have emerged. The fact that the original classification still stands, illustrates the validity of form and design as criteria, and indicates that only the more obvious technical features are essential in primary classification, features which can safely be recognized by the general archaeologist, even though he is often at a loss to describe and explain them. The specific contribution of technology to classification is therefore the rendering comparable of all data by the standardization of methods of identification and description. This, together with the explanation of characteristics, will furnish a means for correct assignment of the large number of borderline and doubtful specimens which in so many fields are a source of confusion and misunderstanding. The study of Pecos Black-on-white types illustrates this possibility. Distinct types were recognized by Dr. Kidder and Mr. Amsden, but a large proportion of seemingly unclassifiable specimens prevented satisfactory grouping of all the material. Once it was found that these types could be differentiated by materials, the origin and relationship of doubtful pieces became clear. The introduction of technological methods should not, consequently, result in startlingly new classifications, but rather make possible the consistent and satisfactory use of features now only imperfectly recognized and understood.

Ceramic technology is a highly specialized branch of archaeological research, requiring training for which the majority of archaeologists cannot spare the time. But technological results need not for this reason be accepted without criticism. Even the untrained reader can evaluate results upon the basis of exactness of description and the quantity of material examined. It is not necessary to know how to determine the optic sign of a mineral in order to estimate the relative value of a specific and detailed mineralogical description, as compared with a vague and generalized one; or to realize that the information gained from the analysis of a hundred thin sections is of greater significance than that derived from the examination in refractive liquids of powdered samples from a few sherds. In all future publication of technological data it is therefore of the greatest importance that specific statement be made regarding the methods employed and the amount of material used. It is also to be hoped that as the value of technology is recognized, more than one laboratory will be established, so that even the most recondite aspects of the work may be subject to independent criticism and check.

The study of pottery offers an exceptional opportunity for the archaeologist to adopt certain procedures of the physical sciences. The accuracy and certainty of results obtained from such methods are in themselves a source of satisfaction. But no less important is the attitude of mind developed by the habit of experimentation and the use of exact and delicate instruments. Archaeology is subject to much futile controversy arising from reliance upon personal judgment and the tendency to elaborate unverified theories. Ascertained facts are often insufficient to supply the detail which we desire in our story of culture history, and so imagination tentatively fills the gaps. Explanations which at first are recognized as purely speculative come in time through repetition and familiarity to be taken far more seriously than their foundation justifies. But whenever an experimental approach becomes possible hypotheses are impersonally submitted to searching test, uncompromising thoroughness and veracity are demanded, and independent and unbiased attitudes are stimulated. These lead eventually to friendly cooperation in the final interpretation of results. In acknowledging our debt to the scientist therefore we cannot fail to realize that his philosophy and ideals are among his richest contributions; and it is to be hoped that, as we borrow methods, we may become imbued in some measure with the spirit which these methods have developed.

PART THREE

DISCUSSION

by A. V. Kidder

"Notes and Queries," with emphasis on the queries, should perhaps have headed the present section. "Conclusions" certainly would not do. For although both Miss Shepard and I have naturally given anxious thought to the broader technological, artistic, and historical implications of our materials, we have found ourselves faced at every turn by questions which we were unable fully to answer because we did not have sufficient knowledge of the pottery of other towns or of other areas. Lack of comparative data has also made it impossible to settle many purely local points, the exact relationship, for example, of one Glaze type to another, or the origin and development of a particular vessel form. But certain problems can at least be formulated.

To begin at the very beginning, we may state that Pecos pottery is a member of the Anasazi ceramic family. In "Anasazi" the reader encounters a term new to Southwestern archaeological parlance, but one rendered necessary, it seems to me, by recent developments.

When we knew less than we now do of the prehistory of the Southwest, it was thought that the remains of the entire area from eastern New Mexico to California, and from northern Utah to Chihuahua and Sonora formed part of a single great development, which was called "Puebloan" or, even more loosely, "Southwestern." But new researches and critical reëxamination of material already in our possession have shown that the southwestern part of the region was occupied by a culture which differed in many important respects from that of the north and east. These differences were dimly perceived by me in 1924, while studying the radically un-Pueblo Red-on-buff pottery of the Middle Gila.[1] They were first clearly stated by Kroeber in 1928, when he segregated the desert culture of southern Arizona under the term "Gila-Sonoran."[2] The ancient manifestations of this culture have of late years been investigated and described by Schmidt, Woodward, and the Gladwins; it is now generally called "Hohokam."[3] A blanket designation, such as "Southwestern," is thus no longer properly applicable to the antiquities of the whole area. How, then, should we refer to the non-Hohokam? "Pueblo" of course comes first to mind, but what to do about the Basket Maker?

Although Basket Maker preceded true Pueblo, and although it has, for better or worse, been distinguished sharply from Pueblo in archaeological literature, it was

[1] Kidder, 1924, p. 112. [2] Kroeber, 1928, p. 379.

[3] See Schmidt, 1927, 1928; Sauer and Brand, 1930; Hawley, 1930; Woodward, 1931. Particularly important are the various papers on the archaeology of southern Arizona by W. and H. S. Gladwin in the Medallion series.

nevertheless an integral part of the whole northern and eastern development. A single comprehensive term would accordingly appear to be desirable. One could use "Basket Maker-Pueblo." This, however, is unwieldy. It might also cause confusion if one wished to speak of either of these two sequent elements of the complex separately. The word Anasazi is therefore proposed. It has the same meaning (Old People) in Navajo that Hohokam bears in Pima. It would apply to the Basket Maker and to those Pueblo groups which can be shown to have derived the basic framework of their material culture from the Basket Maker.

We may now return to our original statement that the pottery of Pecos forms part of the Anasazi ceramic family. But this immediately brings us to grips with a second problem of definition. What is Anasazi pottery? What criteria can be used to set it apart from other families?

There is never the slightest difficulty in telling an Anasazi pot, ancient or recent, good or bad, from a Hohokam vessel or one from the Mounds or Middle America; but it is hard to say just how one does it. Yet the attempt must be made: first, as a step toward more accurate classification; second, to permit segregation of those basic ceramic traits which will become of greater and greater significance when we reach the stage, as some day we must, of considering the broader aspects of New World ceramic history.

Anasazi pottery was made by coiling. This serves to distinguish it from Hohokam ware, which was produced by the paddle-and-anvil method, but not, apparently, from all pottery of eastern United States, nor from that of Mexico. From the Mexican and Eastern categories (we are not yet in position to say whether or not they also should be subdivided into groups comparable to the Hohokam and Anasazi) Anasazi differs in several important particulars: great simplicity of vessel shape; formal, balanced, geometric, painted decoration; use, during the middle periods, of corrugation as a decorative device; lack of paddled, stamped, scored, incised, modelled, or applied plastic ornament; sharp distinction between culinary and non-culinary vessels.

In the matter of vessel shape, Anasazi pottery is notably conservative and, in this particular, markedly different from that of eastern United States and of Mexico. In the earliest times, to be sure, a great variety of containers was produced, many of eccentric or at least unstandardized forms. This is true of the first wares, those of Modified Basket Maker; to a less extent of Developmental Pueblo.[1] By the end of the latter period the shapes were reduced to bowls, pitchers, ladles and two forms of jar: one (generally called the olla) of fine ware and relatively narrow mouthed, for water; the other, of coarser ware and with large orifice, for cooking. There were turned out, of course, at certain times and in certain regions, other sorts of containers: seed-jars, mugs, canteens, etc. But these were seldom numerous and many of them had very restricted distributions, both chronologically and geographically. The bowl, the olla, and the cooking jar were, indeed, the only universally used vessels. These forms were standard. They were also extremely simple. The bowl always tended to be sub-hemispherical, with plain or only slightly modified rim; the olla was, as a

[1] Roberts, 1930, p. 83.

rule, approximately spherical; the culinary jar more or less egg-shaped. Handles, always sparingly employed, became rarer and rarer in the later periods; legs were almost, if not entirely, absent; round bottoms were the rule, although in some early forms, and quite generally in Historic Pueblo ollas, the recurved base was in favor. Effigy vases were extremely rare.

Decoration was in dark pigments on lighter backgrounds, usually slips, or at least carefully prepared surfaces. The practically universal two-color treatments of early days only fully gave way to polychromy in the Regressive Pueblo period. Briefly to characterize so rich an art as Anasazi painted design is difficult, but one may say that it was overwhelmingly geometric and mostly rectilinear; that its fundamental syntax consisted of the laying off of horizontal encircling fields, which were then either subdivided for intensive embellishment or filled with repeating figures, the figures themselves being preponderatingly triangular or stepped, and tending to opposed or interlocking arrangements. Formality, strict balance, and the simplest sorts of alternating rhythms were typical; as was a remarkably close adherence to current canons, calling for the use in any given group of an extraordinarily limited number of minor decorative devices, but the production, from that small stock, of an endless variety of superficially very similar, though almost never exactly duplicating, patterns. Such few naturalistic forms as appeared were highly conventional and were, as a rule, applied to vacant areas, rather than incorporated in patterns.

Surfaces decorated by variations of finish, such as paddling, stamping, scoring, or incising were never popular. Even polishing was seldom attempted, although careful, often meticulous, smoothing was habitual. The retention, on the exterior of culinary vessels, of the structural coils and the embellishment of the coil by repetitive pinchings or indentations were marked features of the late Developmental Pueblo and Great Pueblo periods. The corrugated style, extremely rare in other parts of the world, and nowhere so highly specialized as in Anasazi pottery, presumably prevented the development of the surface treatments seen elsewhere, and, together with the emphasis placed on painted design, may perhaps also have checked the rise of plastic ornament, the result being the evidently strong predilection of all Anasazi potters for symmetrically rounded vessels.

A sharp distinction between culinary and non-culinary containers is characteristic of Anasazi pottery. Pastes and vessel shapes were normally different; decorative methods were not mixed, slips and paints having been restricted to non-culinary forms, corrugation, with very rare exceptions, to those for service in cooking. I am not sufficiently well acquainted with the wares of eastern United States and of Mexico to know whether or not such consistent and marked differences between the two sorts of vessels existed in those regions, but I suspect that they did not.

The Anasazi seldom produced really large pots. In this particular they differed from the Hohokam, who made great numbers of capacious containers, both decorated and plain. Hohokam influence, indeed, may perhaps be seen in the, by Anasazi standards, huge corrugated jars of which fragments are found in Mimbres ruins, and

of which the most noteworthy example is the 60-gallon vessel found by Haury in Canyon Creek.[1]

Further comparative study of vessel form is needed to enable us more accurately to define Anasazi pottery, work of the sort begun by Vaillant in "Some Resemblances in the pottery of Central and North America."[2] Technological differences should likewise be looked for. Such investigations, supplemented by determination of the age, relative to Anasazi, of the early cultures of northern Mexico and the Central Mexican Plateau, of the Mississippi Valley, and particularly of the Hohokam range along the Gila and Salt in southern Arizona, are also needed for solution of the fundamental problem of origins.

To the interesting and important subject of Anasazi ceramic beginnings we can do no more than allude in passing, as we are concerned, in the present paper, primarily with the pottery of the Pecos Valley, a region which played no part in early developments.

Anasazi pottery has usually been considered a peripheral outgrowth of the Mexican-Central American complex. The gross facts of distribution support such a belief. But the strong individuality of Anasazi wares, and failure to discover anywhere in Mexico types recognizable as ancestral or, in northern Mexico, anything approaching the Anasazi in antiquity, has led some observers to feel that the transmission of a bare idea, rather than direct copying, stimulated the making of clay containers in northern Arizona;[3] while others have thought that pottery-making might even have been invented independently in that region. Morris, indeed, although acknowledging the inherent improbability of local origin, placed the burden of proof squarely upon the diffusionists by following Anasazi wares step by step back to apparent prototypes of unfired mud, and by pointing out that no equally full developmental series could be identified elsewhere in the New World.[4] But investigations of the past decade in the Gila-Salt Basin indicate that the Hohokam possessed good pottery at a relatively early period, and in the winter of 1935 the excavations of Gila Pueblo at Snaketown brought deposits to light which suggest that the first Hohokam wares may actually antedate anything found further north.

The most ancient Hohokam material does not, it is true, seem to resemble the oldest Anasazi closely enough to be accepted as a direct prototype of the latter. Nevertheless, it occurs exactly where it should on the theory of an upward spread from Mexico, and, by shortening the gap between north and south, greatly increases the probability of original diffusion from a Middle American nucleus.

[1] Haury, 1934, pl. LXXI. Although it has only indirect bearing on ceramic problems, the observation may here be made that evidence of contact between the Hohokam and neighboring Anasazi groups may perhaps also be seen in textiles. No Hohokam textiles have, it is true, so far been discovered; but the finest and most elaborate examples of Southwestern weaving have almost all emanated from the Verde, the Tonto Basin, Canyon Creek, and the Upper Gila, regions closely peripheral to the Hohokam range in the Gila and Salt Basins, which offers the most favorable environment of the whole Southwest for the growing of cotton. Another probable indication of Hohokam leadership in the textile arts is that no other Southwestern culture produced specially moulded (as distinguished from perforated-potsherd) spindle-whorls.

[2] Vaillant, 1932. [3] Kidder, 1924, p. 121. [4] Morris, 1927, p. 198.

No matter how it got its start, the subsequent development of Anasazi pottery seems to have been largely autochthonous. From its first appearance in Modified Basket Maker until the present day Anasazi ceramics look to have assimilated very little from outside sources. It is of course important that this hypothesis be checked by comparative research, both technological and artistic; and if it be proved true, attempt must be made to determine the causes of the phenomenon. Are ceramic families, among the less advanced cultures, inherently conservative? Or were the Anasazi insulated, in one way or another, against ceramic infiltrations? These questions are of great significance for Southwestern history, for understanding of New World culture growth, and for solution of even broader anthropological problems.

What has usually been considered the earliest Anasazi pottery is that of the Modified Basket Maker in the drainage of the San Juan. And it has been thought that in the San Juan country there also developed such other distinctive elements of Anasazi culture as coursed stone masonry, the clustered pueblo type of dwelling, and the specialized ceremonial room or kiva. But here again more evidence is needed, for what may be called the "San Juan hypothesis," under which all Anasazi (and until very recently all Southwestern) culture was believed to have spread from that region, was formulated by such persons as Morris, Roberts, and myself, who have done most of our work in the San Juan and who, for better or worse, have seen things from an almost exclusively northern viewpoint.

I still believe in the San Juan origin of the architectural traits just mentioned, which did so much to give Anasazi culture its distinctive stamp. And I have thought that the equally characteristic early Anasazi ceramic traits of corrugation and black-on-white decoration on white backgrounds were also part and parcel of the San Juan complex. But if Anasazi pottery owes its origin to that of the Hohokam it seems odd that its centre of later dispersal should have been at so great a distance from the source of inspiration. Indeed, the preponderating importance of the San Juan has been brought into question by Mera's suggestion of the possible influence upon later developments of an early Little Colorado ware (Adamana Brown);[1] and by the Gladwins' elevation of the Little Colorado to equal rank with the San Juan in their genealogical chart of Southwestern pottery.[2]

While I continue to think the San Juan area to have been its breeding ground, I realize that the problem of the growth and diffusion of Anasazi culture is much more complex than I supposed when I wrote my "Introduction" in 1924. The northern people of the Modified Basket Maker period probably had a hand in laying both ceramic and architectural foundations for further development; under the San Juan hypothesis they were almost wholly responsible for moulding Anasazi culture; and the Chacoans, who were the first to gather into really large communities, surely inaugurated and set the pace for the wide-spreading achievements of the Great Pueblo Period. But additional research, prosecuted with understanding of all issues involved, is greatly needed. Specifically, the time-relation between earliest Hohokam and earliest Modified Basket Maker should be determined. This will be no easy task, for although Modified Basket Maker sites can often be dated by dendrochronology

[1] Mera, 1934. [2] Gladwin, W. and H. S., 1934.

there seems little likelihood of the recovery of tree-ring material from Hohokam houses. Cross-traded objects offer the brightest hope. The pottery of each group is readily identifiable; and the Hohokam possessed various artifacts — three-quarter grooved axes, stone palettes, arrowheads of characteristic form — which could be recognized if found in the excavation of Basket Maker or Modified Basket Maker dwellings. Close comparative studies of pottery design and vessel form should also be made. And it is most desirable that additional tree-ring dates be gathered from early ruins in the Little Colorado, Upper Gila, and Mimbres districts in order to learn the age of these sites relative to those of the San Juan. Such information should permit decision as to whether the Black-on-white and Corrugated complex originated among the Modified Basket Makers of the north (as is held by proponents of the San Juan hypothesis), or whether it had its beginnings further south in, say, the Puerco of the West, the streams flowing northward from the Mogollon rim, or somewhere in the Upper Gila or Mimbres drainages.

The above problem is of the greatest importance, for the ceramic complex just mentioned spread over a vast range during the Developmental Pueblo period; it gave rise to the various specializations of the Great Pueblo period, which in turn fathered the wares of late prehistoric and historic times. And correct understanding of the growth, dissemination, and interaction of the multitudinous groups, phases, types, subtypes, and varieties into which modern research is splitting Anasazi pottery depends very largely upon location of the point and time of the complex's origin.

The suggested investigations will throw light on Anasazi ceramic beginnings. They must be supplemented by intensive study of Modified Basket Maker pottery. At present this gives an impression of great homogeneity, but it can hardly be doubted that careful work will reveal geographical and chronological differences, which should also be of value for determining whether it spread from the San Juan or from a more southerly nucleus.

Modified Basket Maker pottery, as has just been said, was a relatively uniform product. In what seem to be the earliest sites, though as far as I know this has not been checked stratigraphically, plain gray ware almost overwhelmingly preponderates over Black-on-white. The latter, indeed, was never really abundant, nor, apparently, did it carry a slip.[1] This ceramic linkage covered a large area, including most of the San Juan drainage, with extensions into the Little Colorado and the upper eastern tributaries of the Rio Grande. The date of its origin is unknown, but it had passed out of existence by 844 A.D. in the drainage of the Puerco of the West, where, at the Allantown ruin, the Developmental Pueblo period had already opened.[2]

In early Developmental Pueblo (old Pueblo I) pottery two divisions have been noted, an eastern and a western.[3] Their exact ranges remain to be worked out, nor have their points of origin been located. And this again is important, for they gave

[1] Roberts, 1929, p. 110.

[2] Miller, 1934, 1935. Dates which have been secured from a number of Modified Basket Maker sites in the San Juan have not as yet been released by Dr. Douglass.

[3] Roberts, 1931, p. 165.

rise to the geographically more restricted types of late Developmental Pueblo and of the Great Period.

The eastern and western groups are most strongly marked by differences in the decoration of Black-on-white ware; both, however, contain service pottery upon which is the beginning of corrugation.[1]

To sketch the further career of Anasazi pottery with the broadest strokes, one may say that from the eastern and western early Developmental Pueblo groups there emerged, in late Developmental Pueblo, a number of more or less local specializations which became still further individualized during the Great Period. The general Black-on-white and Corrugated linkage maintained itself from about 800 to about 1300 A.D. During these five hundred years Black-on-white and Corrugated of many distinctive types, but all obviously of the same great family, were being made over a vast territory. The history of the complex has still to be written. How rapidly it expanded to its uttermost limits is uncertain. There were doubtless spurts and lags. It is often difficult to tell whether primitive traits observable in materials from the fringes of the area indicate age or peripheral unsophistication. But before 1300 the complex had at one time or another been present over a range stretching from eastern New Mexico to Nevada, and from Central Utah to the northern affluents of the Salt River in southern Arizona. In New Mexico it reached the Mexican border.

In the above range and until the above date the two wares had preponderated. Corrugated pottery had never seriously been challenged; Black-on-white, however, was constantly forced to compete with colored types. The struggle must have been going on almost from the beginning, for the older Red-on-buffs of the Hohokam were being made to the south, and a most attractive reddish-brown ware with darker red decorations had a strong, but apparently abortive, vogue during the early Developmental Pueblo period in the northwestern tributaries of the San Juan.[2] Further west, in the Kayenta country, first Red-on-black and later polychrome styles competed strongly with Black-on-white through the whole span of the local Pueblo development. And in the Little Colorado, Black-on-reds were produced in limited amounts from very early times, later gaining strength as the white exterior embellishments of St. Johns Polychrome bowls added to their attractiveness. Glaze, too, was commencing to creep in. The Black-on-whites, however, held their own until about 1300. During the succeeding century their long reign came to an end.

What brought about the final extinction of Black-on-white? It may perhaps be explained as a response to that apparently inevitable law of art (and, for that matter, of all cultural processes) which decrees that the plain shall give way to the com-

[1] It must be remembered that the theory of the origin of corrugation in the neck-bands of northern Early Developmental Pueblo vessels is a corollary of the San Juan hypothesis. It is possible, of course, that neck-bands were a peripheral northern phenomenon and that the cradle of corrugation lay further south, say in the general Upper Gila region, where, in later times, the art of corrugation reached its greatest heights.

[2] This pottery will be described in forthcoming reports by J. O. Brew and E. H. Morris, to be published by the Peabody Museum of Harvard University and Carnegie Institution of Washington respectively.

plex, simplicity be superseded by elaboration. That the old style should have maintained itself for a half-millenium is a striking example of the Anasazi's steady resistance to change; a tendency also manifested in architecture and, judging from the extraordinary persistence of the kiva, in religious and social practices; a conservatism which has held the Pueblos to old ways of life through three hundred years of European contact. Probably contributing, however, to the overthrow of Black-on-white were discoveries of new clays, new firing processes, and new methods of compounding paints. And it was hastened, apparently, by the wholesale abandonment of territory and the shifts of population which took place at the end of the Great Period. The two phenomena were approximately synchronous and must surely have been in some way connected.

From the old Black-on-white root there sprang up a series of polychrome shoots. The tendency to specialize, which was operative in the segregation of local Black-on-white styles, continued and became intensified, giving rise to the even more strongly diversified ceramic categories of the Regressive Pueblo period.

In the upper waters of the Little Colorado, there was experimentation with glaze paints, as exemplified by the Pinedale, Heshotauthla, and Four-mile Polychrome types. Matte paint Pinto Polychrome developed and, below the Mogollon Rim, Gila and Tonto Polychromes. Further down the Little Colorado and in the Hopi country what seems to have been a crossing of Kayenta and St. Johns styles, plus the use of attractive new clays, produced first Jeddito Black-on-yellow and later Sikyatki Polychrome. What proportion of Anasazi ceramic traits entered into the Chihuahua complex is not as yet clear, but certain it is that while the above-mentioned groups were springing up in the north, a series of polychrome types was coming into being below the border. And in the Upper Rio Grande the first steps, as will shortly be described, were being taken toward development of the Glazes.

It will be noted that not until the final sentence of the foregoing discussion has the Rio Grande been mentioned. This neglect of the area, on the eastern edge of which Pecos is situated, and in which we are therefore primarily interested, is due to the fact that the Rio Grande seems to have played no part whatever in the origin of the Anasazi ceramic complex; nor did it ever, save possibly in early historic times, contribute materially to cultures in the west. The Rio Grande received but apparently gave nothing in return. In fact, during the Modified Basket Maker and early Developmental periods the only part of the region to be occupied by pottery making people was the northwestern fringe adjacent to the drainage of the San Juan.[1] Somewhat later, however, a wave of pottery making rolled eastward, crossed the Rio Grande, and extended nearly to the Texas border.

I speak of the above phenomenon as a wave of pottery making, rather than as a spread of population, because it is not known whether it was due to a migration of Anasazi groups from the west, to assumption of Anasazi culture by previously resident non-agriculturalists, or to a gradual infiltration from the Plains, the incoming people becoming increasingly sedentary as they moved westward. The latter hypothesis should be given serious consideration in the course of future research. It

[1] Mera, 1935, Map I.

is reasonably certain that in later times the Athabascans invaded the Southwest from that direction. They did not, it is true, take on Anasazi ways of life, but had the arrival of the Spanish not shortly supervened and provided them with sheep and horses, thus permitting them to continue as nomads, the poverty of the Southwest in game might well have forced farming upon them. An indication of an earlier westward movement may be found in linguistics. The Tanoan languages are believed to be allied to Kiowan.[1] The Kiowa are Plainsmen who can hardly be thought to have strayed eastward, as their earliest known home was on the headwaters of the Missouri, whence they were pushed southward in relatively recent times. And as the Tanoan-speaking Pueblos occupy the eastern fringe of the Southwest, it might be inferred, should their language indeed prove to have affinities to Kiowan, that they too were of Plains extraction. There is still another hint of a westward push at the time when the Rio Grande was becoming, so to speak, Puebloized. The Pueblo kiva took on its characteristic form in the San Juan drainage. This is beyond doubt. And throughout the San Juan it was evidently a most stringent ceremonial requirement that the kiva ventilator should open to the south. One would therefore suppose that if Pueblo Indians had moved into the Rio Grande they would surely have continued to follow this hallowed practice. But the ventilator in ancient Rio Grande kivas is normally on the east. And the east has great significance in Plains ritual.

It may never be possible to determine how and whence the Rio Grande was populated. Physical anthropology may eventually shed light on the problem. It is important that attempt be made to solve it, as interpretation of observed ceramic developments depends upon knowledge of whether pottery making was brought into the region by people moving eastward from the old Anasazi centre, or whether it was taken over by resident or incoming nomads previously unfamiliar with the art.

The above discussion has concerned the manner of the introduction of pottery into the Rio Grande. No matter how this came about, the ultimate derivation was certainly from a western source and the first widely diffused wares were of Developmental Pueblo Black-on-white and Corrugated types. The Black-on-whites were the Chaco 2 and Kwahe'e of Mera, who believes the latter to have been a degeneration of the former.[2] His illustrations of typical sherds, however, do not seem to me to confirm this supposition. His Chaco 2 (pl. I, Mera, 1935) is unquestionably allied to the early type which, for better or worse, is usually called Chaco.[3] But the Kwahe'e pieces which he figures (pl. III) are to my mind not at all Chacoan, from the point of view of decoration. They seem, on the other hand, to resemble more closely a generalized Black-on-white of the northern San Juan which will be described in Morris' forthcoming monograph on the archaeology of the La Plata. My feeling in this regard, however, should not be given serious consideration, for the

[1] Harrington, 1910; 1928, p. 1 and footnote. [2] Mera, 1935, pls. II, III.

[3] Distinctly for the worse, in my opinion, for it is representative of a very widespread Developmental Pueblo group from which the true Chaco types later sprang. There is no certainty that it originated in the Chaco. The Gladwins, indeed, believe it to be of Little Colorado (Puerco of the West), rather than San Juan, derivation (1934, fig. 4 and chart). Be that as it may, the term Chaco should, I think, be restricted to the so-to-speak urban development in that drainage, which inaugurated the Great Pueblo Period, and which exercised potent influence upon neighboring regions.

types involved have not been studied technologically, nor have they been subjected to the searching decorative analysis which is essential for reaching sound conclusions as to the relationship of ceramic groups. Mera may be correct in assigning Chaco ancestry to Kwahe'e, but the published evidence in support of that belief is inadequate. His reconstruction of later Black-on-white developments in the Rio Grande may briefly be summarized.

Kwahe'e and a Black-on-white type called Gallina, which had grown up in isolation north of the Jemez mountains, jointly gave rise, in Mera's opinion, to Santa Fe Black-on-white.[1] The latter eventually changed into Wiyo Black-on-white[2] and Wiyo into the Biscuit wares. Another offspring of Santa Fe Black-on-white, but in this case crossed with Mesa Verde Black-on-white, was Galisteo Black-on-white.[3]

The above may be taken as a working hypothesis. It must be carefully checked, particularly as concerns the genetic postulates. For this, close study of technological features, decoration, and vessel form are required; and much excavation in key sites. A good start has been made by Stallings and Stubbs at the Pindi ruin near the village of Agua Fria on Santa Fe Creek.

In the Pecos Valley, Chaco 2 and Kwahe'e are rare, perhaps non-existent. No sites yielding either were found in the area explored by Phillips Academy in the upper drainage, nor by the Laboratory of Anthropology's survey; and this is odd, because these types occur well to the east near Watrous, as well as further down the Pecos itself.[4] But Miss Shepard has recognized a few Chaco-like sherds from early deposits at Forked Lightning (p. 461).

Here we encounter the first of the many vexed questions with which we shall have to deal in discussion of the ceramic history of the Pecos Valley. Like most of the others, its solution will depend upon further local work, but to an even greater extent upon investigation of relatively much less well-known regions in the vicinity.

The matter may be restated. Why do the supposedly early types, Chaco 2 and Kwahe'e, not appear in our area, in view of their presence, if Mera is correct, to the east? It is possible that proximity to the game-rich mountains may have thrown the upper valley into the range of hunting people who prevented the immigration of agriculturalists from the west, forcing them to detour, so to speak, by way of the lower valley, or to pass through the mountains in the vicinity of Taos in order to reach the country about Las Vegas and Watrous. In the same way Plains groups which might have been drifting westward, assuming Pueblo life as they came, could also have been barred from the region.

But it is not certain that the Upper Pecos Valley was actually untenanted by farmers during this time. Our work there was almost wholly confined to the excavation of a few ruins, and a thorough search of the area was one of the many projected activities that were given up when Phillips Academy withdrew from Southwestern research. So early ruins may actually exist, either on unexplored mesa-tops, or still buried under later remains at Forked Lightning, Rowe, or Pecos. The few Chaco-

[1] The Pecos Valley representative of this type is the Amsden-Shepard Blue-gray.

[2] Amsden-Shepard Biscuitoid. [3] Amsden-Shepard Crackle. [4] Mera, 1935, Map I.

like sherds found by Miss Shepard in the lower cuts of Test D, Forked Lightning, may evidence such a settlement there.

Again, the eastern Chaco 2-Kwahe'e materials noted by Mera may not actually be older than the oldest pottery found at Forked Lightning, in which case the Chaco-like sherds of that site's deep strata might have come from vessels made by contemporaneous easterners. On the whole, however, I am inclined to think Mera correct in believing that there were early settlements to the east and northeast, and that if the Pecos Valley was indeed untenanted at that time, its lack of pottery-making inhabitants is to be attributed to the presence of hostile hunters.

The problem is clearly formulated. It can probably be settled by further research. First of all, the ceramic types concerned should be studied intensively. Chaco 2 should be defined and its technological and decorative characters compared with those of similar types (themselves as yet undefined) from the supposed place of its origin in the Chaco or the Little Colorado. Kwahe'e must undergo the same specific and comparative treatments. Also, excavations will have to be made at ruins near Tecolote, Watrous, and Springer to determine the stratigraphic relationships of Chaco 2 and Kwahe'e, and of both to Santa Fe Black-on-white. Particularly careful search should be carried on for briefly inhabited villages containing pure representations of any one of the three types. This is most important, for only at such sites can one avoid the inevitable mixing which takes place in the refuse of longer-lived communities. More excavation should be done at Forked Lightning, Rowe, Loma Lothrop, Glorieta, and other ruins in the Pecos Valley, with special emphasis upon stratigraphy. Finally, there is need of studies upon house-architecture, kivas, and all sorts of non-ceramic artifacts.

To continue discussion of ceramic events in the Pecos Valley. The Forked Lightning ruin is the only Black-on-white site, among the several which exist, that has been more than scratched. It yielded a very large collection of sherds. Part of this collection, mostly the stratigraphic material, has been studied by Mr. Amsden from the point of view of the general archaeologist; and by Miss Shepard, who concentrated upon the technological aspects of the wares. Their results are remarkably, and most encouragingly, in agreement. The gist of their findings is that the Black-on-white pottery of Forked Lightning may be divided into two general categories: Blue-gray and Crackle, the former preponderant during the early days of the settlement, the latter coming strongly into favor toward the end of its occupancy. The local and regional problems raised by these types have been treated in detail by Miss Shepard. The most striking of her conclusions is that a large amount of the pottery at Forked Lightning was imported; and although the question of trade was considered in the Introduction, and was again, and more fully, scrutinized by Miss Shepard in her several interpretative sections, it is of such outstanding importance that it seems well to give it further attention.

To begin with, there can be no question that certain ingredients, not obtainable in the Pecos Valley, were used in the manufacture of an extraordinarily great proportion of the vessels that saw service at Forked Lightning and Pecos. Miss Shepard believes that these vessels were made in the regions producing the non-local materials, and her reasoning seems to me sound. Every effort, however, should be made

to settle the matter beyond doubt. Conclusive proof will perhaps never accrue. But, as Miss Shepard suggests, the first step should be a thorough examination of the pottery from the regions which produce the non-Pecos ingredients. A start has been made in this direction (see p. 483), but the work should be carried much further. Specifically, the decoration of Santa Fe and Galisteo Black-on-white needs meticulous analysis, and Blue-gray and Crackle, the local representatives of those types, should receive the same treatment. If there proves to be no difference between the designs of the material from Forked Lightning and that to be collected in the ruins from which the supposedly traded pottery is thought to have come, the case for importation will be strengthened. Particularly close comparison should also be made of the untempered Blue-gray, which may have been made at Forked Lightning, and the tuff-tempered pieces that would appear to have emanated from the Rio Grande Valley. For this study great quantities of Forked Lightning sherds are available in the Department of Archaeology at Andover. Much Crackle is also in the collection, both from Forked Lightning and from Pecos.

Because of our relatively slight knowledge of the Black-on-white types from the Pecos Valley, and our almost complete ignorance of the nature and distribution of those of the Upper Rio Grande, it is impossible to interpret the involved ceramic conditions disclosed at Forked Lightning by Miss Shepard's study. It seems clear, however, that this and the several other contemporaneous villages in the Valley were under strong influences from the north and west. An important point to be settled is whether the Valley was unique in this regard, or whether a corresponding lack of independence obtained in the towns farther east; another is what caused the shift in source of vessels (or of ingredients) from the Rio Grande Valley to the Galisteo Basin. Was Santa Fe Black-on-white actually older than Galisteo (partly ancestral, according to Mera's hypothesis); or were the two more or less parallel developments upon which Forked Lightning drew at different times?

The Pecos Valley possessed, at all events, no distinctive Black-on-white ware of its own until after Forked Lightning had been abandoned and the village on the Pecos *mesilla* had been occupied for a considerable number of years. There then came into being the Rowe type (Amsden's Late Crackle), a pottery tempered with surely native sand or siltstone. Rowe Black-on-white conveys an impression of degeneracy, but its deficiencies, like those of Local Glaze I Red and Glaze II, may be due to inexperience on the part of the potters who made it. If this was really the case, it would indicate that no decorated ware at all had been produced in the Valley during the whole span of Forked Lightning's occupancy, and the first years of Pecos.[1] Although this seems most unlikely, it must be considered as a possibility, as none of the earlier types has ingredients that could not have been obtained in other areas, and a very large percentage of them contain demonstrably foreign temper. If many hundreds or thousands of vessels were imported, as they must have been if Miss Shepard is right, why not all? And if any decorated pottery was being turned out at home, why bring in so much? The more I mull over this question, the more confused

[1] Small, smooth pebbles of the sort usually, and probably correctly, identified as pot-polishers were, however, found at Forked Lightning. Kidder, 1932, p.64.

I become. And I keep returning to the idea that the early inhabitants of the Pecos Valley may have been easterners, who had taken over Pueblo architecture and farming practices, and had perhaps learned to make cook-pots, but who, for some reason or other, found it more convenient to get their finer ware from older established groups. But pottery making is so integral a part of Pueblo culture that this is scarcely credible. At all events, it is obvious that Miss Shepard's technological findings have raised most serious problems. Everything was quite simple until she brought her relentless microscope to bear on the sherds from Forked Lightning.

Rowe Black-on-white was not a virile type. It appeared late; never, apparently, gained complete ascendancy over the combined tuff- and sherd-tempered types (see Graph IX, p. 478); and after a brief struggle succumbed, with them, to Glaze I and Biscuit A.

With the decline and final extinction of the Rowe type, Black-on-white pottery passed out of use. It was succeeded by the Glazes. A similar shift to colored wares was taking place, or had already done so, throughout the whole Anasazi range. The reasons for this general abandonment of the old style, which had enjoyed so long a reign, and which had covered so vast a territory, have already been discussed. At Pecos it was doubtless hastened by the introduction of Glaze I. I say introduction advisedly, for it is certain that Glaze I did not come into being at this town. It is therefore necessary, before following its local career, to inquire into its origin, which in turn involves consideration of the genesis of Pueblo glaze painting.

To begin with, it should be stated that the use of vitrified pigments is without question a native art. This was first pointed out by Hewett, who observed that Glaze was present at many sites which he classed as prehistoric, because his excavations revealed in them no trace of European contact, nor were they mentioned in the careful list of inhabited pueblos compiled by the Spanish explorers and colonizers. He also recognized the fundamental difference between Pueblo and Old World glazing, i.e., that the former is a mere application of decorative lines, while the latter is a method for rendering a vessel less pervious to moisture by treating its whole surface with a vitrified coat.[1] The case for aboriginal invention was subsequently still further strengthened by the finding of glaze by Nelson, Hodge, the writer, and others, at many sites which stratigraphic evidence proved to have been even older than those from which Hewett drew his conclusions. Finally, the studies in dendrochronology of Douglass and his pupils have given us actual dates in the 1300's and 1400's for ruins at which glazing was practiced.[2]

Decoration in glaze must be considered an autochthonous Southwestern development, because no other New World pottery is so treated; nor, indeed, was glazing of any sort intentionally produced elsewhere in the Americas, save possibly in Salvador upon the so-called Plumbate ware.[3] There being no question of the process having been brought in, one must attempt to locate the place of its origin within the Southwestern field.

[1] Hewett, 1908, pp. 83, 84.

[2] The latest and best discussion is by Haury (1932). Hough (1928) is the only archaeologist who has considered Glaze a post-Spanish trait.

[3] Spinden, 1915, p. 470; see also Linné, 1925, p. 138. Miss Shepard states that no Plumbate sherd which she has examined bears a true glaze.

Vitrified paint appears sporadically upon Black-on-white vessels as far back as the Modified Basket Maker period. E. H. Morris informs me that he found two such specimens in graves on the La Plata in northwestern New Mexico; and one from the same area that dates from early Developmental Pueblo (Pueblo I).[1] From the early part of the Great Pueblo period, similar paints are not unknown: in 1908 I collected three sherds (now in the University of Utah Museum) from "proto-Mesa Verde" sites on Alkali Ridge, southeastern Utah, with decorations in a thin, purplish-black, evidently vitrified paint; I have seen a vessel with paint of identical appearance which was said to have come from White House, Canyon de Chelly, Arizona.[2] But in the San Juan at least, such occurrences are so rare as to appear the result of accidents which were not followed up and which therefore did not at the time give rise to a new method of decoration.

The earliest customary use of glaze seems to have been toward the close of the Great Pueblo period in the drainage of the Little Colorado. Black-on-white vessels with glossy paint have long been known in pot-hunters' collections from that region. On stylistic grounds they seemed to be late, but it was not possible to be sure of their chronological position prior to Haury's excavations at Showlow, a ruin on Silver Creek, Arizona, whose older deposits carried a mixture of Black-on-white and St. Johns Polychrome. The Black-on-white (with the exception of a few Chaco-like pieces apparently emanating from a still earlier horizon) was of a type with Upper Gila affinities. Its paint was dull black, but in certain cases had a "lustrous silvery appearance."[3] Showlow deposits which contained the above materials were dated by dendrochronology at about 1200 A.D.

It would seem that the secret of producing vitrified paint, which potters had long been on the verge of learning, had this time actually been grasped, for in the succeeding archaeological horizon, at the nearby Pinedale ruin, dating from about 1290, Haury found an increased percentage of Black-on-white with glaze decoration, as well as a habitually glaze decorated, red slipped ware which he named Pinedale Polychrome.

Glazing was thus well established by 1290. Indeed, two forms of the process were being used, as the vitrified paint of Black-on-white vessels from Pinedale contains, according to analyses by F. G. Hawley, neither lead nor copper, both of

[1] *Modified Basket Maker specimens:* 1) Bowl from Site 19 (U. of Colo. Mus. cat. no. 2228). "A considerable portion of the pigmented areas of one panel of the interior decoration became glazed on firing." 2) Bowl from Site 23 (cat. no. 3449). "Rim line, central ring and encircling band are drawn in a black which did not spread evenly. The dots and some of the border of the band are dim and thin, but here and there the border lines and the triangles based upon them received much thicker pigment. In these places there was produced a thin glaze." *Developmental Pueblo (Pueblo I) specimen:* Bowl from Site 33 (cat. no. 3776). "This bowl was much altered by the burning of the building. It is of leaden color tinged with brown, but the paste in cross-section shows surface layers of salmon tint. The paint became glazed where thickly applied, and very dark brown in color."

[2] Mr. Morris states in a recent letter that in the La Plata certain specimens with vitrified paint "run on into early Pueblo III, the glaze on them being heavier than on the very early ones. The most notable is No. 4366. The grayish paste of the vessel vitrified on firing, but did not run, swell or blister. The design is an intense, highly lustrous black glaze in perceptible relief."

[3] Haury and Hargrave, 1931, p. 27; pl. 7, no. 1.

which were found by the same chemist to be ingredients of the Pinedale Polychrome glaze.[1] Pinedale Polychrome gave rise, in Haury's opinion, to Four-mile Polychrome, a ware the period of whose existence "may be ascribed to the last half of the 14th Century, although it may have been present as early as 1330."[2]

Haury's data from Showlow and Pinedale confirm my long held belief that glazing originated in the Little Colorado, rather than in the Rio Grande,[3] for no Rio Grande Black-on-white ware adumbrates, as does the lower level Showlow Black-on-white, the rise of the process; and the earliest glaze decorated specimens from the Rio Grande are all either obviously imported Little Colorado pieces, or exhibit strong Little Colorado influence. Furthermore, the first surely local Glaze type (Mera's Agua Fria Glaze-on-red = Glaze I Red), is red, a color previously almost entirely unrepresented in Rio Grande ceramics, but much in favor with contemporary and earlier Little Colorado potters.

How the discovery was made will probably never be known. It must, of course, have been purely empirical. One supposes that some unusually keen-witted potter, noticing the attractive appearance of a vessel which, like many of her predecessors, she had decorated with paint containing an accidental admixture of flux, duplicated the compound and, finding that it achieved the same pleasing results, communicated the receipt to others.

Although glaze painting was apparently first practiced on Black-on-white vessels, its later use was more commonly for the decoration of red-slipped pottery. Pinedale Polychrome would seem to have been the type upon which it got its real start. Haury believes Pinedale Polychrome to be a development from St. Johns Polychrome, and this appears likely, as it carries on various St. Johns decorative traits, and as, according to the evidence from Forked Lightning, a thin glaze already began to appear on St. Johns before the rise of Pinedale (p. 362). There is, however, the most urgent need of further excavation in the upper Little Colorado, for while surface sherd surveys are useful to determine the distribution of types and, to a certain extent, to block out problems, they cannot be relied upon to supply the exact information upon chronological associations which is essential for understanding ceramic developments. We do not as yet really know anything about the ancestry or the subsequent differentiation of the early Glaze types in that area.

Several of these are recognizable: Pinedale Polychrome, Four-mile Polychrome, Heshotauthla Polychrome. The Hawikuh Glazes, although most important for Little Colorado archaeology, are, for the most part, probably too late to have a bearing on Rio Grande problems. Haury considers that Pinedale gave rise to Four-mile. The exact relationships of Heshotauthla are still unknown and it is essential that we should have more information regarding this type, for, as will be shown, it

[1] Haury, 1932, p. 423. The suggestion is there made that the glaze of the Black-on-white may have been a sodium compound.

[2] Haury, 1931, p. 45.

[3] Kidder, 1915, p. 454. Hewett, who was the pioneer excavator in the Rio Grande country (Bandelier, essentially a documentary historian, did little or no digging), considered glaze decoration to have been discovered in that area, a natural and, on the basis of ecidence then available, reasonable inference from the fact that the technique there reached its highest development (Hewett, 1908, p. 84).

may have inspired the first Rio Grande Glazes. Like Pinedale it is probably derived from St. Johns. It has many resemblances to Pinedale. It is probably earlier than Four-mile. It is therefore to be inferred that it was contemporaneous with Pinedale. Neither Pinedale nor Four-mile reached Pecos in trade, at least we recovered no specimens of them. But Heshotauthla was imported to some extent at least, occurring in late Black-on-white sites (Dick's, Rowe) and in the earliest Black-on-white-Glaze I strata at Pecos. It is therefore the type which, if Rio Grande Glaze is due to influence from the Little Colorado, should theoretically have exerted that influence. And the first effect should, again theoretically, have been felt in the western part of the Rio Grande, nearest the source of stimulation. Mera, indeed, has proposed a type named Los Padillas Polychrome which he locates in the Rio Grande valley below Albuquerque and which he believes to represent a transition between Little Colorado Glaze and Agua Fria Glaze-on-red (=Glaze I).[1] This is an interesting hypothesis. But excavation is needed to check it and particularly to supply specimens of Los Padillas Polychrome and of earliest Agua Fria to permit us to work out the ancestry of Glaze I decoration. Until such material has been secured one can do no more than draw a few comparisons between the designs of Glaze I and those of types from which Glaze I might have derived artistic inspiration.

As to Los Padillas Polychrome decoration we have no information save that provided by Mera in his description of the type: "— though still following St. Johns styles to a certain degree, there was a definite move towards simplification and a growing away from the over-elaboration that was so characteristic of the western type, nor was longitudinal hatching so prominent a feature (Plate XVII). In addition many design elements borrowed from local black-on-white styles are apparent. Another western trait was preserved in the use of simple geometric patterns, executed with matte white paint, which were placed below the rim on the exterior surfaces of bowls. Patterns showing the use of both broad and narrow lines are to be seen."[2] The nine sherds illustrated (Mera, 1935, pl. XVII) seem to indicate absence of the heavy upper framer so characteristic of Glaze I; and of the equally typical Glaze I panels. Decoratively, the specimens in question appear to be of Little Colorado type rather than transitional.

For comparison of Glaze I decoration with that of Heshotauthla Polychrome there are somewhat fuller, but by no means satisfactory, data. Fewkes has published color reproductions of several bowls from the Zuñi country,[3] and a few sherds from Pecos are illustrated in the present volume (fig. 291). Resemblance is seen in the preponderance of bands and the lack, in both types, of all-over bowl interior patterns. The heavy upper framing line occurs rarely, however, in Heshotauthla (Fewkes, pl. V, 1), and when it does appear it is balanced by a second equally heavy

[1] Mera, 1935. The specimens mentioned in the section on Heshotauthla Polychrome (p. 364) as having affinities to Glaze I Red probably belong to this transitional type. All the early Glaze material, however, requires more intensive study (see p. 387).

[2] In the Pecos Valley there is positive evidence that broad lines in matte white bowl exterior decoration (St. Johns Polychrome, fig. 290, *a-f*) preceded narrow lines (Heshotauthla Polychrome, fig. 290, *g-i*). I doubt very much whether material exhibiting both these features can properly be assigned to a single type.

[3] Fewkes, 1909.

lower framer, never used in Glaze I. Some Heshotauthla bands possess sets of thinner framers within the heavy outer ones (Fewkes, pls. IV, 6; V, 7), a practice foreign to Glaze I; most bands are simply confined by banding lines, the upper one close below the rim (Fewkes, pls. IV, 4, 5; V, 1, 2, 3, 5, 8; our fig. 291, *g*, *i*). The bands of the two types are radically different, in that Glaze I examples are practically invariably paneled, whereas those of Heshotauthla apparently are not often so treated, and when they are, division is by sets of narrow vertical lines (Fewkes, pls. IV, 7; V, 3) rather than by the single heavy paneling bar or the open space characteristic of Glaze I (cf. fig. 8); nor, in Heshotauthla, does alternation of unlike pairs of panels appear. Heshotauthla bands run to current designs, the commonest of which is based on obliquely set, connected rectangles (Fewkes, pls. IV, 4; V, 8; our fig. 291, *g*, *i*—the same decorative concept is seen in many of the narrow line white exterior designs, Fewkes, pl. IV, 5, 8; our fig. 291, *h*).[1] In minor elements, the two systems have little in common, although the stalked keys with base (cf. Fewkes, pl. V, 4; our fig. 16) exhibit a sort of family resemblance; and the stepped line is found in both (Fewkes, pl. V, 6, 8; our fig. 52). A radical difference is the entire absence, in Glaze I, of the white decorations habitually applied to the exterior of Heshotauthla bowls. One concludes that, aside from the use of glaze paint, Glaze I decoration can have derived very little from Heshotauthla Polychrome.

We turn, in our search for prototypes, to the Black-on-white wares which existed in the Rio Grande before the introduction of red slips and glaze paint worked so violent a ceramic metamorphosis. But we find ourselves faced by an almost entire lack of material for comparison. The Indians of the Rio Grande, in pre-Glaze times, were wretchedly parsimonious in the matter of mortuary pottery, so that our museums contain no collections of whole vessels. Nor, save at a few sites near Santa Fe and in the Pecos country, has excavation been done in the rooms and rubbish heaps of the Black-on-white villages in order to gather larger sherds than can be obtained on the surface. Invaluable data will accrue from the intensive analysis of designs from Pindi ruin now being made by Stallings and Stubbs of the Laboratory of Anthropology. But their results are not as yet available. We are accordingly forced to revert to the Pecos Valley, a district rather far removed from the postulated place of origin of the early Rio Grande Glazes. The Forked Lightning Black-on-whites, however, have not as yet been examined from the point of view of decoration, the time at Mr. Amsden's disposal having been only sufficient for a study of the relatively few whole vessels from Pecos itself. And these are probably all very late specimens; most of them, indeed, seem to have been contemporaneous with, or very little older than, Glaze I.[2]

[1] This highly characteristic Anasazi arrangement is probably derived by elaboration of opposed keys (cf. fig. 291, *h*). Were its occurrences worked out, much light would be thrown on the morphology of Anasazi patterns. Some connection between it and the slung rectangle of Pecos Glaze panel embellishment (fig. 17) may be suspected.

[2] This statement is based on the fact that the Pecos Black-on-white vessels came, for the most part, from graves, where some of them were actually associated with Glaze I bowls. The others are supposedly late because in earlier times, as at Forked Lightning, pottery was practically never placed with the dead. The increase of grave furniture, which marks the Glaze periods at Pecos, is perhaps, like the introduction of glaze paint, due to western influence.

Comparing the decoration of Pecos Black-on-white, the majority of which is of Rowe (Amsden's Late Crackle) type, with that of Glaze I, we find that while bands predominate in Black-on-white, there are a number of all-over patterns (Vol. I, fig. 14); these are of the greatest rarity in Glaze I. Of the bands, two important Black-on-white categories, those based on lines and small pendant triangles (Vol. I, figs. 5, 6), and those based on zigzags and offset triangles (Vol. I, fig. 8), fail of representation in Glaze I. Paneled bands, however (Vol. I, figs. 10-12), the most common Black-on-white arrangements (see Amsden's excellent analysis, Vol. I, pp. 55-60), definitely link the Rowe type with Glaze I. For instance, the heavy, broken, upper framer, though not conventional, is present (Vol. I, fig. 10, *a*); paneling is sometimes by heavy bars (Vol. I, figs. 10, *a*; 11, *c*); and, probably most significant, there is use of the typical Glaze I A,B,A,B system of the alternation of two pairs of unlike panels (Vol. I, fig. 10, *d*, *e*, and probably *h*). Methods of panel subdivision likewise show analogies (cf. Vol. I, fig. 13; Vol. II, figs. 12, 39). A lune-like arrangement is found in Rowe (Vol. I, fig. 16, *f*). Comparison of the elements of design reveals fewer similarities. The large, and as yet unstudied, sherd collections from Forked Lightning and Pecos should be scrutinized from this point of view. Hatching, however, as Mr. Amsden states, is less used in late than in early Black-on-white.

Biscuitoid (Mera's Wiyo), also a late Black-on-white type, bears extraordinarily close resemblance to Glaze I in the frequency of pendent triangle patterns framed above by a single, heavy, broken line, the triangles themselves being paneled in typical Glaze I manner and, in one case, bearing birds on their apexes (cf. Vol. I, fig. 16, *b-d*; Vol. II, figs. 20, 48). Could these last specimens be proved older than Glaze I, we should have unmistakable prototypes for certain parts, at least, of the Glaze I decorative system. But their patterns, and those of Rowe as well, may have been copied from Glaze I bowls. In this connection, it should be remarked that Biscuitoid (Wiyo) is a tuff-tempered type which presumably had its origin in the Santa Fe region or even further north, while Glaze I is supposed to have developed in the Rio Grande Valley south of Albuquerque.

To sum up. It appears that, decoratively, Glaze I owes little to the Little Colorado type, Heshotauthla Polychrome. It has greater similarities to the Upper Rio Grande Black-on-whites, particularly to the late types, Rowe and Biscuitoid (Wiyo). Such similarities, however, may possibly be due to a back-wash, so to speak, from Glaze I. There we must leave the problem. It is one of much significance for Rio Grande archaeology, as well as for more general studies of the development of decorative art, and of the methods in which decorative styles influence each other. Its solution depends upon searching design analysis based on adequate collections of Los Padillas Polychrome and of the various Black-on-whites, particularly those to be found in the Galisteo Basin and in the Rio Grande Valley below Bernalillo.

Miss Shepard believes that Glaze I, both Red and Yellow, was not made at Pecos. Her reasons have already been set forth (pp. 581-583). I entirely agree with her. It is conceivable, though I do not think it likely, that the Black-on-white vessels containing foreign ingredients were made locally of imported materials, for the specimens in question are apparently not fundamentally different, either in

decoration or vessel form, from pieces which may have been being made contemporaneously in the Pecos Valley.[1] But Glaze I breaks violently with all local tradition in color, paint, and vessel-form. The olla, for example, is exceedingly rare in Pecos Black-on-white, abundant in Glaze I. The variable rim (thinned, rounded, outcurved) of the Black-on-white bowls is replaced by the squared bowl rim of Glaze I. Black-on-white bowls are of irregular contour and there is a wide range of sizes, while those of Glaze I are excellently moulded and of strikingly uniform capacity. In decoration, Glaze I departs perhaps less radically from Pecos Black-on-white canons; its designs, however, are very much more standardized, and I believe, although I know too little about Black-on-white decoration to be certain, that new elements, or at least new treatments of elements, are present in Glaze I.[2] Finally, it is inconceivable that potters who were turning out such comparatively poor stuff as the Rowe type could have become capable, so to speak overnight, of making vessels as fine as those of Glaze I.

As against the above it may be argued that Glaze I was the product of experienced persons who had settled at Pecos and who returned to the vicinity of their former homes to gather materials with the use of which they were familiar. But how, in that case, to account for the sudden lamentable falling off in moulding, glazing, and design as soon as local ingredients appear in the vessels (Local Glaze I Red, Glaze II)? That seems surely to indicate copying by unskilled hands when, for unknown reasons, possibly economic; possibly political, the source of imported ware was cut off. The degeneration cannot be charged to clay or temper, as those of the Pecos valley are equally as good as anything that could be obtained from other regions—witness the excellence of the results achieved with them in Glaze IV and V. The burden of proof lies, I think, upon those who disbelieve in importation of finished vessels.

Having, to my own satisfaction at least, located the origin of glaze decoration in the Little Colorado; having followed Mera in placing the ware ancestral to Agua Fria Polychrome (Glaze I) in the Rio Grande Valley; and having brought Glaze I by trade to Pecos, we are ready to consider the subsequent ceramic history of that village.

How long the Glaze I period lasted is uncertain. We do not even know exactly when it opened. To arrive at an estimate requires resurvey of such chronological data as are at present available.

St. Johns Polychrome, the ware which without much question gave rise to the early Little Colorado Glazes—Pinedale Polychrome and Heshotauthla Polychrome —was apparently being made about 1200.[3] My reasons for believing that it cannot date as far back as was suggested by Roberts' findings at the Village of the Great Kivas in the Zuñi country are given above (p. 353). By 1290 it had been superseded by Pinedale Polychrome on Silver Creek, and as this general region was in or close

[1] I qualify this statement because further study of the Black-on-white types, which are at present very imperfectly known, particularly from the point of view of decoration, may reveal distinctions between the specimens which are thought to be the result of trade and those produced at home.

[2] For example, the slung rectangle, two-dash exterior decorations, etc

[3] Haury, 1932.

to the former centre of its production it seems unlikely that it was being made anywhere as late as the end of the 13th Century. One may accordingly guess that 1150 to 1250 would span the lifetime of St. Johns Polychrome.

We have no identifiable pieces of Pinedale Polychrome from Pecos. Nor do we know the relative ages of Pinedale and Heshotauthla Polychrome. This is unfortunate, because the latter, as we have seen, pretty surely played some part in the genesis of Glaze I. But Pinedale and Heshotauthla look to me to be parallel, though somewhat divergent, developments from St. Johns, Pinedale having later given birth to Four-mile, Heshotauthla to the Hawikuh (Zuñi) Glazes C and D described by Hodge.[1] If this is so, Heshotauthla should, like Pinedale, date from about the end of the 13th Century to, say, the middle of the 14th Century; and Los Padillas Polychrome, the Rio Grande Glaze which is thought to have originated from it and in turn to have given rise to Agua Fria Glaze-on-red (=Glaze I Red), might have been in process of development in the Rio Grande valley during the first quarter of the 14th Century. The first Agua Fria may thus tentatively be placed at around 1350.

Attacking the problem from the Rio Grande side, we have a tree-ring reading of 1310 ± 5 from a Black-on-white ruin in Water Canyon on the Pajarito (Lab. Anth. No. 545), and an estimated date of 1310 ± 10 from another near Lamy (Lab. Anth. No. 27). Surface survey failed to reveal Glaze at either one. By 1390, however, Glaze I had made its appearance in the Pecos Valley, for it occurs at the Glorieta ruin, where a kiva yielding the above date is "correlated with the early development of Pueblo IV."[2]

From the foregoing evidence, the year 1375 may tentatively be assigned for the beginning of the importation of Glaze I into the Pecos Valley.

The duration of Glaze I cannot be postulated with any degree of assurance. The great quantities of Glaze I rubbish encountered during the Pecos excavations gave me the impression that the period, in comparison with those of Glazes II and IV, had been a long one. But conclusions based on relative amounts of débris are at best unreliable—the population may, for example, have been larger during Glaze I than it was during certain subsequent periods; the principal refuse beds of those periods may not have been tapped by our trenches. Our sampling, however, was reasonably thorough, and there is no reason to infer intermittent shrinkages of population. Accordingly, I am inclined to think that Glaze I, including the overlap of I Red by I Yellow, had a fairly long career.

There is no direct evidence for dating the homemade imitations of imported Glaze I which we have called Local Glaze I Red. But I am quite sure that the latter type was not long in use before being superseded by the light-slipped type, Glaze II. And there are indications that the latter was being made around the year 1450. The lowest strata of the rubbish below the South House at Pecos contains, as far as our rather extensive trenching showed, nothing earlier than Local Glaze I Red. There was very little even of this, the bottom layers running almost straight Glaze II. It is

[1] Hodge, 1923, p. 29.

[2] Stallings, 1933, p. 805. The Water Canyon and Lamy determinations are from the same source.

therefore reasonable to suppose that the structure on the *mesilla* above the midden was erected at about the beginning of the Glaze II period. The South House beams which have been dated by Stallings were almost all cut in the 1430s and 1440s.

A second indication for assigning Glaze II to about the middle of the 15th Century is offered by the Frijolito ruin on Pajarito Plateau, from which Stallings has a reading of 1447. This site yields Biscuit B (first appearing at Pecos in Glaze II) and a Glaze which, though differing in some particulars from Pecos Glaze II, is obviously closely allied thereto.[1]

Glaze I, then, is believed to have lasted from 1375 to 1425, Glaze II from 1425 to 1475. No data were gathered at Pecos to aid in the chronological delimitation of Glazes III and IV. Glaze V, however, was in use early in the historic period.

Because I found no European objects in the stratigraphically earliest Glaze V deposits, whereas such materials were present in later Glaze V horizons, I originally believed that Coronado's visit in 1540 took place during that period, a somewhat naïve assumption in view of the brevity of his stay at Pecos and the improbability of his party having introduced sufficient foreign objects to make a showing in the middens. Nor could any of the other Spanish *entradas* prior to the colonization of New Mexico in the early years of the 17th Century have brought great amounts of trade-goods. My earliest china-, glass-, and copper-bearing strata should therefore most probably be assigned to around 1625. If this be correct, the uncontaminated Glaze V deposits might be considered as belonging to the first quarter of the 17th Century. I cannot place them much earlier because I have already brought Glaze II nearly to 1500, and I feel that at least 100 years must be allowed for Glaze III, which is represented by very heavy beds of refuse, and for Glaze IV. And that Glaze IV was in existence during the 16th Century seems proved by Stallings' beam readings of 1507-1565 from Puyé, a Pajarito ruin which produces a Glaze closely similar to Pecos IV.

To sum up again, the Pecos Glaze III period is tentatively dated 1475 to 1550; Glaze IV, 1550 to 1600, the latter being allotted a shorter span than the former because of its smaller representation in the rubbish heaps.

Glaze V had, I am sure, a relatively long life. There are great masses of Glaze V rubbish. There are time-connoting changes in the type itself (e.g. the development of Late Glaze V). However, only one definite chronological landmark is discernible. This was the finding in the adobe bricks of the Pecos Mission of Glaze V, but no later, sherds. The mission, according to Benavides "Memorial," had been built by 1620.

The above data merely show that Glaze V was being made during the first quarter of the 17th Century. How long it persisted is still uncertain. We know that Modern painted (Tewa Polychrome) which ultimately supplanted Glaze at Pecos, had already been developed to the north and northwest by the time of the Pueblo Revolt of 1680, for Mera found it at the ruins of the temporary refuge village of the

[1] Frijolito wares are described in Kidder, 1915. It is interesting to note that the Glaze of many Frijolito specimens (Peabody Museum of Harvard) is "beaded" in apparently much the same manner as that of Pecos Glaze I Red (see p. 3), although the vessels bear glaze-bordered red decorations and are thus stylistically allied to Glaze II rather than to Glaze I Red.

San Ildefonso Indians on Black Mesa, besieged by de Vargas in 1694,[1] as did Nelson at the Keresan pueblo of Kotyiti on the Potrero Viejo (1683-1684).[2] Nelson, however, states that it is scarce in all pre-Revolt Tano ruins except San Marcos, the northwesternmost of that group. As Tewa Polychrome was thus apparently uncommon in the Galisteo Basin before the Revolt, it may well not have come into general use at Pecos until 1700.[3] So continuing our tentative time-reckoning, we may assign to Glaze V, including both Late Glaze V and the presumably more or less contemporaneous Glaze VI intrusion, the century between 1600 and 1700. Modern painted was the leading decorated ware from 1700 to the final abandonment of Pecos in 1838.

The following tabulation recapitulates the chronological estimates. The dates given for the founding of Forked Lightning and for the move to the Pecos *mesilla* are frankly guesswork. These and other events of importance for Rio Grande ceramic history will doubtless be dated more accurately when W. S. Stallings has completed dendrochonological researches now in progress.

1150	Forked Lightning founded
1300	Forked Lightning abandoned, Pecos founded
1300-1375	Black-on-white period at Pecos
1375-1425	Glaze I period
1425-1475	Glaze II period
1475-1550	Glaze III period
1550-1600	Glaze IV period
1600-1700	Glaze V period
1700-1838	Modern period
1838	Pecos abandoned

Before undertaking discussion of the problems arising from study of the Pecos Glaze types, it is necessary to summarize our present knowledge of the archaeology of the Upper Rio Grande during the Regressive Pueblo period.[4]

The term "Regressive," as I have stated earlier in this book, conveys a false impression of conditions in the Rio Grande, for the period in question was there marked by a cultural vigor in many ways comparable to that of the Great Pueblo period in other parts of the Southwest, during which time the villages of the Rio Grande drainage in New Mexico, though numerous and occupying an extensive territory, were for the most part small and their wares, Black-on-white and Corrugated, were inferior imitations of contemporaneous or somewhat earlier western types. Mera has plotted the distribution of these Rio Grande wares, and has formu-

[1] Mera, 1932, p. 12. [2] Bandelier, 1892, p. 178; Nelson, 1916, p. 176; Mera, 1932, p. 12.

[3] The period 1680-1695 which, because of wholesale abandonment of towns and the founding of new ones, offers so many opportunities for accurate dating of ceramic types, is not archaeologically marked at Pecos, because that village was occupied without serious interruption throughout the troublous years of the Revolt.

[4] This stage of Anasazi culture history (old Pueblo IV) is usually considered to have lasted from about 1300 to the end of the Pueblo Revolt in 1690.

lated hypotheses to explain their origin and development.[1] As to other aspects of Black-on-white period Rio Grande archaeology: house-types, kivas, masonry, burial customs, non-ceramic artifacts, we know next to nothing, as the attention of archaeologists has until very recently been almost entirely devoted to the larger sites of later times.[2] So we have insufficient background to permit us to judge as to how much of the richer culture of the succeeding period was of local origin and how much was due to influences from outside sources. The fact, however, that this development began at approximately the same time as the abandonment of the great communities of the San Juan leads one to suspect that an influx of new blood from that region may have acted as a stimulant. Whether this, or whether pressure of wild tribes, served to bring about concentration of the hitherto scattered Pueblo units into larger and larger villages is as yet unknown. The giving up of considerable territory apparently well suited for agricultural life renders hostile inroads the more plausible explanation.

The new, larger pueblos extended from the Chama and Taos in the north to about San Marcial in the south, being situated, for the most part, in the valley of the Rio Grande or on the lower drainages of its affluents. Pecos was the easternmost of these towns. Ceramically they were not homogeneous. One can discern two divisions: a northern, in which Biscuit wares preponderated; and a southern, characterized by the manufacture of Glaze. In the Jemez valley a small group of villages (Mera, 1935, Map 3) produced a pottery, Jemez Black-on-white, which has not as yet been described, but which seems to have developed rather slowly from older Black-on-white wares.

The Biscuit area has been ably discussed by Mera in a paper which lays the foundations for all future work in the northern part of the Rio Grande drainage.[3] It shows how much valuable distributional information can be obtained by the surface sherd survey, and how intelligent analysis of the materials can be used to outline historical events. The three maps, illustrating conditions at about 1400, 1500, and 1600 indicate that, as elsewhere in the region, shrinkage in occupied territory was accompanied by increase in the size of towns, and by a drawing in of the population toward the valley of the Rio Grande. Correlations are also suggested, on the evidence of intrusive Glaze sherds, between the Biscuit and Glaze types. This sort of cross-dating is, however, as Mera points out, never entirely conclusive, as exact chronological relationships can only be established by stratigraphic excavation.

Mera believes Biscuit to have been dervied directly from Wiyo Black-on-white (Biscuitoid), and there can be no doubt that it indeed had a Black-on-white ancestry. But his statement that "numerous sites yield all stages of transition"[4] requires fuller substantiation, as it implies a more gradual change than appears to be justified by the evidence. Technologically, such a transition is at least unlikely, Miss Shepard having determined (p. 497) that the clays of Wiyo and Biscuit were

[1] Mera, 1935.

[2] The admirably conducted excavations by Stubbs and Stallings of the Laboratory of Anthropology at Pindi and other Black-on-white ruins near Santa Fe will aid greatly in remedying this condition.

[3] Mera, 1934; see also 1935, Map 2. [4] Mera, 1934, p. 9.

so unlike that the shift from the one to the other would seem of necessity to have been abrupt; and, in decoration, the differences between Wiyo and Biscuit are considerable, that of the former seeming, from what little we know of it, to be highly variable, while that of the latter is rather rigidly standardized. This standardization we are as yet unable to interpret. It may be the result, as Mera supposes, of a lengthy process; but, on the other hand, it may have taken place much more quickly. So acceptance of the Mera hypothesis should, I feel, be deferred until the decorative material illustrating the stages of the postulated transition has been presented.

I have made much of the above point, because upon its solution depends judgment as to whether Biscuit grew from Wiyo as part of a general stylistic trend, or whether Biscuit sprang into being as result of some single potter's discovery of the virtues of a clay hitherto unused, and the concurrent development, by her or by her immediate associates, of a new mode of decoration, the novelty and attractiveness of the combination favoring rapid diffusion with consequent stifling of older practices. In other words, was the phenomenon a mutation or a more leisurely evolutionary process? An answer to this question would be welcome. Again and again in the history of Anasazi ceramics, types appear which are rooted, clearly enough, in older work, but which apparently take on, so to speak overnight, such marked individuality that it is hard not to be a mutationist, attributing the change to the influence of one potter, or at least to a small school of potters. And that this can actually occur is proved by the radical changes which have been effected in San Ildefonso pottery by Julian and Maria Martinez and in Hopi ware by Nampeyo. It may, of course, be argued that these are archaistic revivals, artificially stimulated by commercial demand for the new product. But the Pueblos are so conservative a race that it is hard to believe them, even today, capable of actions psychologically impossible for their ancestors. And that an attractive new product might find a market not fundamentally different from that which the tourist business has opened for the work of Maria and Nampeyo, seems much more likely since Miss Shepard has disclosed the wide pottery trade of prehistoric times, than it did when we believed that every village supplied its entire requirements by home manufacture.

Before leaving this matter it is perhaps necessary to state that abrupt changes may sometimes seem to have occurred merely because we have not succeeded in finding transitional material. In the present case, indeed, it is believed by Mera to exist. Thus we are offered opportunity to work on a clearly formulated problem, the solution of which will throw much light on one aspect of the archaeologically all-important question of the mechanics of ceramic evolution.

The Biscuit area, as Mera has shown, was a small one. This is probably due to territorial restriction of the peculiar clays of which Biscuit was made. Between it and the region whose ruins yield practically nothing but Glaze there is a strip of country, including the Upper Pecos Valley, the vicinity of Santa Fe, and parts of Pajarito Plateau, where considerable admixture is observed.[1]

The Glaze area was considerably larger than that dominated by Biscuit. It extended from the latitude of Santa Fe south to San Marcial, including, in addition

[1] Mera, 1934, p. 19. For remarks on conditions on Pajarito Plateau, see Kidder, 1915, p. 458.

to the valley of the Rio Grande, a narrow strip to the west of the river; and a much wider one on the east, which takes in the upper valley of the Pecos, the Galisteo Basin, and the Manzano Basin (see Mera, 1935, Map 5). All this country has been diligently surveyed by Mera, whose forthcoming reports will be of great value in defining the distribution of the various chronological and regional Glaze types.[1] And the excavations at present being conducted by the University of New Mexico will also supply much needed data on the ruins in the Rio Grande Valley in the vicinity of Bernalillo. This section of the valley and the Galisteo Basin may well prove to have been active centres of Glaze development.[2]

Pecos, although on its extreme eastern frontier, belonged definitely to the Glaze area. When the town was founded Black-on-white was, as we have already seen, the leading decorated pottery. A few St. Johns Polychrome vessels, probably heirlooms brought from Forked Lightning or elsewhere, were still in use. Toward the end of the Black-on-white period there was present a small amount of red pottery with glaze decoration, some of which almost surely came from the Little Colorado (Heshotauthla Polychrome), some perhaps from the Rio Grande Valley, where Glaze may have been getting its eastern start (Los Padillas Polychrome). The culinary ware was preponderantly Indented Blind-corrugated. The Glaze period was opened, at Pecos, by a tremendous influx of decorated vessels which we believe to have been imported. Black-on-white fell, apparently rather quickly, into disuse, but it is not known whether local manufacture of decorated ware temporarily lapsed, or whether Rowe, the one certainly native Black-on-white type, continued to be produced until the Pecos women began to copy the imported Glazes. Further careful excavation in parts of the ruin containing Glaze I deposits should solve this problem. When the original investigations were going on Local Glaze I Red had not been recognized and no information was therefore gathered as to its possible overlap with Rowe, which, as a matter of fact, had not as yet been distinguished as a separate Black-on-white type.

The new decorated types which caused so complete and apparently so rapid a change in the complexion of Pecos ceramics were Glaze I and Biscuit A, the former probably traded in from the west, the latter from the north. For a short time Biscuit A competed with Glaze on a basis of approximate equality, but well before the end of the Glaze I period it had fallen to the secondary position which it occupied thereafter (for statistics, see Vol. I, p. 157). The earliest Glaze type was I Red, as was also the case in the Galisteo Basin.[3] Glaze I Yellow, however, soon gained parity, and, toward the end of the period, became the commoner. Culinary ware was Indented Blind-corrugated. Miss Shepard believes that while some of the early Glaze I importations (vessels with basalt temper) may have come from the Rio

[1] To be published by the Laboratory of Anthropology.

[2] Because practically all early excavation was done there, the Pajarito Plateau was formerly thought to have played an important rôle in the history of the Rio Grande Glazes. The Laboratory of Anthropology survey has indicated, however, that its people took little if any part in building up the complex; and that even in later times they occupied a peripheral position (Mera, 1934, p. 14; 1935, Map 5).

[3] Nelson, 1916, p. 172.

Grande Valley, the greater part was brought from the much nearer pueblos of the Galisteo Basin (p. 579).

After a certain length of time Pecos women began to copy the imported Glaze vessels. Their first attempts, seemingly, were to reproduce the handsome I Red type. This process may possibly have begun, as was stated in the last paragraph, while Rowe Black-on-white was still being made, and before Glaze I Yellow attained its full popularity. The new homemade pottery, Local Glaze I Red, was markedly inferior, and its manufacture was soon abandoned, possibly because, as Miss Shepard has suggested, the Pecos women could not discover any nearby source of reasonably satisfactory red slip clay. Better light colored slip materials, however, were at hand and experimentation with them doubtless began while Glaze I was still being imported. This resulted in the development of Glaze II and the local manufacture of glaze-decorated pottery was put solidly on its feet.

I originally believed Glaze II to be a degenerate form of Glaze I Yellow. But in the light of Miss Shepard's determination that it was the first Pecos Glaze, its deficiencies are most reasonably to be ascribed to inexperience. This illustrates the danger of drawing conclusions on the basis of stylistic criteria alone, and one is led to wonder if some of the other apparent degenerations, observed in Anasazi ceramics, e.g. of Mesa Verde Black-on-white, of Sikyatki Polychrome, or, to come closer home, those postulated by Mera for certain Rio Grande Black-on-white types, may possibly not have been due to causes not hitherto suspected. Closer study of Glaze II decoration and comparison with that of contemporaneous Glaze vessels from the rest of the area may eventually permit recognition of features characteristic of a borrowed, as distinguished from a moribund, system of design. Such information would be of great value. In the absence, however, of the requisite data one can only state that the copying process, at Pecos, resulted in a lowered standard of execution and in simplification of patterns. Greater attention also began to be paid to the decorative value of the glaze paint, thus putting into action a trend away from detailed treatments and toward large, simple renderings. Whether this was peculiar to Pecos, or whether it was part of a general artistic movement throughout the whole Glaze area, cannot yet be stated. At present it seems that Pecos potters were perhaps always prone to work along broader lines than their neighbors.

Glaze II differs from Glaze I not only in technological and decorative inferiority, but also by taking on certain new features, thickened bowl rims, for example, and the painting of glaze-bordered red figures on the exteriors of bowls and the necks of ollas. Closely similar changes were occurring at about the same time in other parts of the area, as is proved by material collected by Morris at sites near Santa Fe, by the writer at Frijolito on Pajarito Plateau, as well as by Mera's sherd survey.[1] It is therefore evident that Pecos was participating in a widespread ceramic movement. Pecos, however, was probably not a leader. This is to be inferred from the town's peripheral position, and also from the fact that having hitherto imported its Glaze pottery, rather than making it at home, its women were doubtless not yet sufficiently

[1] The Santa Fe vessels are illustrated in fig. 72, *c-f;* those from Frijolito in Kidder, 1915, pl. XXVII; the survey data upon rim form are presented in Mera, 1933, p. 4.

adept to have been innovators. From what village, or group of villages, inspiration was drawn we cannot tell until we know the pottery of other parts of the Upper Rio Grande as well as we do that of Pecos, nor until further dendrochronological studies permit identification of the ruins at which the new features made their first appearance.

The Glaze II period was not a long one. This, of course, only means that the Pecos potters soon became skillful enough to make vessels so much better than those produced by their initial efforts that they are recognizable as a separate type (Glaze III).

No extensive deposits of pure Glaze II were found at Pecos. Hence we have little knowledge of the makeup of the ceramic complex of that time. It is certain, however, that Biscuit B had already appeared in the Pecos Valley.[1] It came, presumably, from pueblos in the north. Trade in other decorated wares would appear to have been slight. The great flow of Glaze from the west was cut down; there is no evidence of Little Colorado importations, and Hopi yellow ware was introduced in very limited quantities (see p. 369). Culinary pottery was still Blind-corrugated, but the vessels differ in shape and in surface finish from earlier types (see fig. 270).

In Glaze III the pueblo seems to have taken on a new lease of life, both architecturally and ceramically. This increased cultural vigor was accompanied by a renewal of contact with the west, but the bulk of the incoming pottery was now Hopi rather than Little Colorado ware. We do not yet know, however, if this came from the Hopi country proper, or if it was made further east in such villages as that on the Rio Puerco of the East near Los Lunas, New Mexico, whose rubbish contains large amounts of Hopi sherds. The point can undoubtedly be settled by technological investigation. Why the Little Colorado failed as a source of trade is not known. It may possibly have been due to the fact that the Rio Grande towns were now producing satisfactory Glaze pottery of their own and that western Glaze was accordingly no longer a novelty. But some other, as yet unguessed, factor may have been operative, for Pecos (and, as far as we know, the whole Upper Rio Grande) seems at this time to have been insulated from all southwestern influences. We have, for example, no single sherd of Four-mile Polychrome, Pinto or Gila Polychrome; nor did the *Glycimeris* shell bracelets, which flowed so copiously out of the Gila into the Little Colorado and the Hopi regions ever, apparently, reach Pecos. The three-quarter grooved axe is likewise absent.

Artistically, Glaze III was a distinctly better product than Glaze II. The glaze paint averaged more lustrous, and patterns began to assume a strength and sureness and an individuality not seen in the older type, whose decorations were, in essence, poor copies of alien originals. Red exterior embellishment became the rule. Bowl-rims were further modified. As in the case of Glaze II, it is evident that Pecos was not alone in these developments. Analogous changes were taking place elsewhere. Pecos pottery was, I suspect, achieving a certain amount of decorative independence, although this cannot conclusively be demonstrated until we know more of the wares from other sites. But that its potters were nevertheless still drawing upon outside

[1] Kidder, M. A. and A. V., 1917, p. 356, footnote 2.

sources is suggested by the fact that certain elements of Glaze I design such as opposed stalked keys were practically absent from Glaze II, but reappeared strongly, though in somewhat altered form, in Glaze III. It is to be supposed, in this case, that the device was kept alive elsewhere during Glaze II and was then reintroduced at Pecos.

It is certain, because of the more or less similar development of pottery throughout the area, that the Glaze towns kept in close touch with one another. The phenomenon can hardly be attributed to parallel evolution. Inter-village visiting must have given opportunity for women to see the products of their contemporaries and, indeed, there came, to Pecos at least, a great amount of pottery from other pueblos, as is shown by the 6-8% of Glaze sherds with non-local temper that appear in material from the Glaze II to IV horizons inclusive (see p. 579). An important point which must eventually be settled is whether Pecos was unique in this regard, or whether there was also large-scale interchange among the villages nearer the centre of the Glaze area.

Glaze IV presents interesting problems. The stratigraphic tests made during the early years of the Pecos excavation seemed to indicate that this type made a sudden appearance, persisted for a rather short time, and passed equally suddenly out of use. I was unable to discern a transition between Glaze III and IV, or between IV and V. It therefore then appeared that Glaze III might have developed directly into Glaze V, with Glaze IV being made as a separate type during the process. Mrs. Kidder and I summed the matter up as follows:[1]

> "Found in the same strata that produce the latest forms of Type 3 and the earlier forms of Type 5, is a certain percentage of pieces scarcely, if at all, different from the pottery which in a former paper we have called "Pajaritan," and have described as Type 4 in the present one. It seems to come in abruptly, runs but a short course, and abruptly disappears, apparently with no preceding or succeeding type. Its high, rather thin rims, red color, good glaze, and specialized decoration, do not fit at all well in the Pecos series. It was commonly buried with the dead, as were Types 1, 2, and 3; while Type 5 vessels were almost never so deposited. One of three conclusions might be arrived at: (1) that it was really transitional between 3 and 5, but that we have not sufficient evidence or sufficient acumen to enable us to recognize it as such; (2) that it was a short-lived secondary style, arising from Type 3 and running a course parallel to early Type 5; (3) that it was made by a group of people from the Pajarito who settled at Pecos, as the Hano did at Hopi, were assigned a section of the site, made their own style of pottery, and continued their own mortuary customs; finally losing their cultural identity or moving away."

Subsequent study has shown the first of the above hypotheses to have been correct, for when the decoration of the Glazes was analyzed the transitional nature of Glaze IV patterns, which of course could not be made out from the small sherds

[1] Kidder, M. A. and A. V., 1917, p. 357.

collected in testing, became clearly evident. And that our 1917 graphs indicated an almost overnight arrival of Glaze IV was due to the fact that in our classification of the sherds we placed most pieces transitional between Glazes III and IV in the Glaze III category, because of their light-colored slip and because the bowl rims still retained some Glaze III attributes. This of course resulted in throwing the beginning of our Glaze IV curve into the air. As a matter of fact, we later found beds of pure Glaze IV refuse in the ruins of the pueblo, which led us to believe that this type must have been intermediate between III and V, rather than contemporaneous with early Glaze V.

While the chronological position of Glaze IV is thus established, and while, as has been brought out in the descriptive sections, its decoration originated, in major portion at least, from that of Glaze III, eventually to change into that of Glaze V, the type nevertheless broke sharply away from both earlier and later canons in the use of red slip, in excellence of brushwork, and in the stressing of decorative detail. Here again we seem to see the effect of outside influence. Red pottery was perhaps becoming popular elsewhere and the fashion was taken up at Pecos. Possibly there was an actual influx of potters, caused by the abandonment of other towns. Something, at any rate, induced a change in slip-color and a notable improvement in painting. As Miss Shepard has failed to find good red slip clays in the Pecos Valley, it is to be supposed that those used in the manufacture of Glaze IV were sought at a distance or acquired in trade. Clay and temper, however, were of local origin, and after a certain length of time the Pecos potters reverted to the more easily obtainable light-colored slips. These, indeed, began to return to favor while decoration still held to Glaze IV standards. At this stage there were turned out such vessels as are illustrated in figure 143, *c*, *d*, which, both in design and in rim form, are clearly transitional between Glaze IV and Glaze V.

Imported pottery, during the Glaze III and IV periods, was for the most part Biscuit B. Biscuit ware after showing great strength, in the form of Biscuit A, at the very beginning of the Glaze I period (Vol. I, p. 157), dropped to the minor position which it held through Glaze IV, to disappear early in Glaze V. Vessels from the Little Colorado were apparently absent during Glazes III and IV, the only pottery to have reached Pecos in any quantity from without the Rio Grande area having been Hopi wares, first Jeddito Black-on-yellow, later Sikyatki Polychrome. The correlation between these types and the Pecos Glazes is unfortunately not precise, due to lack of recognition, in the field, that two Hopi types were involved, with consequent failure to catalogue individual sherds (see p. 369). The notes indicate clearly, however, that in Glaze III and IV Hopi importations were heavier than in earlier or later times. Some 165 fragments were collected, mostly from strata of those periods, but as they were culled from hundreds of thousands of sherds it can be seen that they really constituted an insignificant fraction of the Pecos ceramic complex, even when they were most common.

The cooking pottery of this general horizon was a thin-walled, excellently moulded product, Blind-Corrugated with large shallow indentations (fig. 270). Vessels similar in shape and surface finish seem to have been made at about the same time on the Pajarito Plateau.

The gradual abandonment of red slips and the concurrent thickening of the bowl rim mark the change from Glaze IV to Glaze V and the opening of the epoch of Pecos's greatest ceramic independence. Until then Pecos seems to have been an integral part of an apparently fairly homogenous development throughout the whole Glaze area. This belief rests, however, on somewhat tenuous evidence, as we have no data regarding the pottery of other towns save that on rim form presented by Mera, Nelson's brief characterization of Galisteo types, and the present writer's superficial study of vessels from the Pajarito Plateau.[1] But there is no doubt that in Glaze V the local potters emancipated themselves from their neighbors, who appear, though evidence regarding their products is meagre, to have pursued the stylistic trends of Glaze IV. This is seen most clearly in the bowl rims, which became still taller and thinner, eventually to assume the outcurved form characteristic of Glaze VI.[2]

At Pecos the bowl rim shrank, so to speak, into itself, growing thicker and rounder. At the same time the interior decoration of bowls was reduced to a mere encircling red, glaze-bordered stripe, bowl exteriors still retaining modified, and in general simplified, renderings of the red figures of the earlier Glazes. The art of the other pueblos of this period is not as yet known. We therefore cannot tell whether or not similar changes were widespread, but at Pecos they are strongly marked and are safely attributable to an increasing desire to produce a handsomer and more lustrous glaze. It is uncertain just what steps were taken to achieve the desired effect, but applications were at any rate much thicker, and the compound spread, and even ran, on firing to such an extent that it was useless to attempt the drawing of neat or accurate patterns. Detail was accordingly more and more eliminated, emphasis coming to be placed upon the large, bold figures which alone could display the rich glossiness of the paint without losing all meaning.

That Glaze V was made at Pecos is evident from the nature of its paste. It would appear, indeed, that it was perhaps made only there, for its characteristic yellowish-white slip and peculiar bowl rims render it easily recognizable, even in small fragments; and such fragments are rare in, or absent from, collections from other parts of the Glaze area. A few sherds occur at the nearby Galisteo Basin sites. These contain tempering material identical with that of Pecos Glaze V (see p. 519) and they doubtless came from Pecos in trade. Taos is the only locality which yields significant amounts of pottery similar to Pecos Glaze V, but in the absence of technological studies it is impossible to say whether it was a local or an imported product.

At the height of this period the ceramic complex of Pecos consisted only of Glaze V and the excellent Faint-striated cooking ware (see p. 319). Biscuit had ceased to be imported, at least in quantity, very few sherds of this pottery having

[1] Mera, 1933; Nelson, 1916; Kidder, 1915. Publication of the abundant Glaze material recently excavated by the University of New Mexico at the ruins near Bernalillo will throw much light upon this problem.

[2] Mera, 1933, pp. 7, 8.

been found in Glaze V deposits.[1] Biscuit, as a matter of fact, had probably already been succeeded in the north by Sankawi Black-on-cream, but even this was represented by only a few small bits (see p. 369).

In the matter of actual imports and of stylstic influences, the time in question was, for Pecos, one of very unusual freedom from ceramic dependence upon other communities. It covered, if my chronological estimates are correct, almost the whole 17th Century. And to judge by the number and size of the buildings that appear to have been occupied during Glaze V, the pueblo was then larger and more prosperous than it had ever been before. The Spanish had colonized New Mexico; by 1620 the great Mission had been erected, and a Catholic priest was in residence. The introduction of Christianity resulted in bringing to an end the custom of burying vessels with the dead, but European contact had no effect upon the manufacture of pottery save, perhaps, in suggesting the shallow "soup-plate" form (see p. 273) and the clay "candlestick" (see p. 276). It has been suggested that the less controllable glaze paint of the late period might have been compounded after a Spanish formula,[2] but Miss Shepard finds it to contain the same ingredients as do the earlier glazes.

Changes, however, began to take place toward the end of the 17th Century. The standard Glaze V, which, from the great amounts of rubbish containing it, must have been made for a long time, underwent the modifications in vessel form and in the further breaking down of design which permit the segregation of the variety we have called Late Glaze V. In the deposits carrying Late Glaze V there are found the first specimens of Glaze VI; and shortly thereafter, Plain Red, Plain Black, and Modern painted pottery put in their appearance.

Unfortunately, material for study of this important period is most unsatisfactory. No really good stratigraphic evidence could be obtained, as the upper layers of the rubbish heaps suffered severe erosion during the hundred years which elapsed between the abandonment of the pueblo and the beginning of our excavations. Nor did we find, in rooms or kivas, any considerable beds of unmixed débris of later date than middle Glaze V. Hence we could not determine the exact chronological relation of Glaze VI to Late Glaze V, and of these two to early Modern painted, Plain Red, and Plain Black.

Glaze VI is obviously an extremely degenerate type. The vessels are poorly made and their decoration is mere daubing. Inability to discern any clear transition between Glaze V, even in what were obviously its latest manifestations, and Glaze VI, led me, soon after the excavations began, to doubt that the one had been derived directly from the other. And the much greater abundance of pottery seemingly identical with Glaze VI at the ruins of San Cristobal naturally raised the suspicion that our specimens had come from the Galisteo Basin. This has been confirmed by Miss Shepard, who finds that Glaze VI sherds from Pecos are almost all tempered with non-local igneous rock. The type is therefore evidently an importation.

[1] Small numbers of early sherds may always be expected to find their way into late strata as result of breakage of heirlooms, churning of refuse, etc. At Pecos even Black-on-white occasionally turned up in débris of the historic period.

[2] Nelson, 1916, p. 176.

Seen in the above light, certain peculiarities of Glaze VI are more easily understandable than they were when it was thought to have been derived from Pecos Glaze V. Its tall, outcurved bowl rims, for example, seem to be traceable to a continuation of the heightening begun in Glaze IV. This raising and bending of the rim did not find favor at Pecos, where the thick Glaze V rim developed, but it progressed steadily in other parts of the area, as is shown by the profiles of Mera's Group E sherds, which are roughly contemporaneous with Pecos Glaze V.[1] And such characteristics as very high percentage of red-slipped vessels, and lack of glaze-bordered red embellishments, neither of which could be recognized as logical evolutions from the light-slipped and consistently polychrome Glaze V, can now be explained as having developed, probably in the Galisteo Basin, during the time that Glaze V was likewise degenerating into Late Glaze V.

Late Glaze V, however, is a better ware than Glaze VI. One wonders, accordingly, why the latter should have supplanted it. For this it did, quite definitely, for a short period. And then the whole complexion of Pecos ceramics was altered by the rise of the Modern group—Modern painted, Plain Red, and Plain Black.

As has been explained, stratigraphic conditions at Pecos were so poor as regards the later horizons, that the exact sequence of the various wares is uncertain. And because it was not sacked or deserted during the Pueblo Revolt of 1680, Pecos provides no archaeological evidence for tying the Revolt years into our ceramic history. However, the tremendous upheavals of that calamitous decade may well have shaken things up to such an extent as to give a final quietus to the evidently fast weakening Glazes and to have facilitated the introduction of attractive new wares.

Modern painted (Tewa Polychrome) pottery originated, without much question, in the old Biscuit area. And that Biscuit ware through Sankawi Black-on-cream contributed to its development, is probable. Mera (1932) believes Sankawi Black-on-cream to be "directly derived" from Potsuwi'i Incised (p. 7), but considers its decoration "clearly derived" (p. 10) from Biscuit. The latter statement is certainly correct, but that regarding the influence of Potsuwi'i upon Sankawi must, as Miss Shepard has shown, be checked by technological study. Even should Potsuwi'i and Sankawi pastes be proved identical and different from the paste of Biscuit, the fact that Sankawi is, like Biscuit, light-slipped and that its decoration is obviously of Biscuit origin, while Potsuwi'i is unslipped or mica-washed, surely indicates that Potsuwi'i should not be called a "prototype" (Mera, p. 8) of Sankawi. At most, the latter may have had a mixed ancestry. There should be reviewed, in this connection, Miss Shepard's timely remarks regarding the danger of loose usage of terms implying genetic relationships (see p. 496).

Sankawi Black-on-cream, as I have said, probably contributed to the development of Modern painted ware. But in this case, again, it would be hazardous to postulate too direct a descent. Like Sankawi, Modern painted is, for the most part, tuff-tempered, it also bears a light slip peculiarly well suited to receive matte paint of organic origin. On the other hand, Modern painted vessels bear red slips and paints, substances which require a firing treatment different from that employed

[1] Mera, 1933, p. 7.

for the earlier matte paint wares. And, in decoration, Modern painted departs very radically from Biscuit standards.[1] On the whole, the type appears to be the result of a combination of Biscuit-Sankawi and Glaze traits. But it was more than a mere hybrid, for its designs establish an entirely new and highly original style.

Material permitting demonstration of a slow transition from Sankawi may yet come to light, but at present, as for the origin of Biscuit A, one is tempted to postulate a ceramic mutation, the achievement, perhaps, of a small group following the lead of some unusually gifted potter. Careful excavation of middle and late 17th Century ruins in the Biscuit area and meticulous technological and artistic studies of their pottery are badly needed.

No matter how it got its start, Modern painted evidently emanated from a region where tuffs abounded, the great bulk of the specimens collected at Pecos being tempered with this substance. That they reached the pueblo in trade is further indicated by the fact that the few sand-tempered, and therefore probably locally made, pieces are inferior in decoration to the tuff-tempered majority (see p. 551).

Two other wares made their appearance at about the same time—Plain Black and Plain Red. Approximately half the sherds of Plain Black are tuff-tempered, while those of Plain Red are for the most part tempered with sand (see p. 547). The origin of these types is as yet a mystery. No undecorated red pottery, nor any smudged black had been made in this region in earlier times. In the Southwest as a whole, smooth-surfaced plain red pottery had its greatest vogue in the Gila drainage and in Chihuahua. Smudged black, in the form of bowls, was also popular on the Gila, particularly along its upper tributaries; only in Chihuahua was this technique, so far as I know, applied to small-mouthed containers. But all the southern reds and smudged blacks had seemingly passed out of use and been long forgotten before similar wares got their start in the Upper Rio Grande. One can therefore hardly attribute their genesis in that region to imitation of any other Anasazi or Hohokam product. It would thus appear that they may have evolved independently in our area. The making of undecorated red vessels was of course no remarkable achievement, as red-burning clays had successfully been handled in the Glaze area for generations. And although smudging might easily have been discovered accidentally, it is a much less obvious process than mere failure to decorate, and so one should not take for granted that it was worked out *de novo* in the Rio Grande. It might have been learned from Mexican Indians accompanying the Spanish colonists, a possibility perhaps strengthened by the fact that much of the Plain Black pottery found at Pecos was tuff-tempered and therefore doubtless came from exactly the region first settled by the Spaniards.

From the end of the Glaze I period to the beginning of Glaze V the town had been supplying most of its own needs in the matter of decorated vessels. It is true that it kept step, more or less, with the rest of the Glaze area, but it seems not to have been unduly subservient to other towns. And in Glaze V it not only achieved even greater stylistic independence, but the quality of its products, both decorated and culinary, was quite as high, if not higher, than ever before. It is accordingly not

[1] See also discussion of these points in Vol. I, p. 161.

easy to understand the marked ceramic retrogression of Pecos during the Modern period. As far as we know, it suffered less than did most other pueblos during and after the Revolt. It is thought that not until toward the middle of the 18th Century did Comanche raids and the inroads of disease initiate the decline that ultimately depopulated the town. Yet in these apparently still prosperous times the Pecos potters relapsed once more into mediocrity, wholesale importation of vessels seems to have been resumed, and those that were made at home were of distinctly lowered quality, as is evidenced by the inferiority of the sand-tempered, and so presumably locally-made, examples of Modern painted and Plain Red wares. The contemporaneous cooking vessels (Heavily-striated, see p. 320) were also less gracefully formed, more carelessly finished, and possessed a much more friable paste than those of the preceding Glaze V period. It may be that the above-mentioned attacks and epidemics began earlier than has been supposed; or other adverse factors of which we are as yet ignorant may have led to the breakdown of the potter's art. It is possible, on the other hand, that retrogression in this industry was not linked with unfavorable economic conditions. New interests might have induced the Pecos women to slight their pottery. A notable increase in the handling of buffalo products, for example, could have rendered hide-tanning and the making of leather goods for trade to the west more profitable than moulding and firing vessels. Once started, a trend of this sort could quickly have caused an increase of importations and deterioration of such ware as was still produced at home. A similar phenomenon is at present taking place, I am told, at Zuñi, whose women are said to be abandoning pottery-making because they have found that it pays them better to devote their time to the manufacture of silver-and-turquoise jewelry.

While most of the foreign pottery that was brought to Pecos during the Modern period seems to have originated in the old Biscuit, tuff-tempering area, a not inconsiderable amount also emanated from the Jemez region in the form of Tsia Polychrome (p. 377). From greater distances came a few Zuñi and Acoma vessels (pp. 374, 380).

As has been said, we know relatively little of the ceramic history of Pecos during the shift from Glaze V to the Modern group. Our information is even slighter for the period from 1700 to 1838, in which year the few survivors abandoned the pueblo and emigrated to Jemez. The rubbish heaps yielded scant evidence because, as the village shrank in size, refuse was scattered here and there about the houses and plazas, or was dumped in small quantities into disused rooms, and much less than before was thrown on the great midden along the eastern slope, which for so many centuries had received regular increments of household sweepings, and in which was accumulated so complete a record of earlier pottery developments. And while we encountered a few pockets of Modern refuse in the rooms, such deposits were seldom extensive, nor could their exact chronological interrelation be established. To tell the truth, I failed fully to realize the importance of this period until after excavation had ceased. For this reason, and because of other considerations which will be discussed in the concluding volume of the Pecos series, I dug very few 18th Century rooms. It is, however, certain that careful work on the north and east sides of the Great Quadrangle, if undertaken with knowledge of the problems involved, would supply

a great deal of valuable information upon what is at present the least understood phase of Anasazi ceramic history.

In summarizing the results of our study of Pecos pottery, we reach the somewhat depressing conclusion that we have been devoting our efforts to the wares of a town which was peripheral to an area which was itself peripheral. We have seen that the settlement of the Upper Rio Grande by sedentary, agricultural Indians only took place at a relatively late date; that its first wares, Black-on-white and Corrugated, were derived in one way or another from those of peoples to the west or northwest; and that, of the two characteristic Upper Rio Grande wares of the Regressive Pueblo period, Biscuit probably developed from the so to speak secondarily derived Rio Grande Black-on-whites, while the Glazes doubtless owed much to inspiration from the Little Colorado. The Upper Rio Grande has thus proved to have been essentially a receptive area, and our study of Pecos has suggested that it, in turn, stood in a similar relation to the more centrally located villages of the Upper Rio Grande, as it seems to have been dependent, throughout much of its career, upon actual importation of a large portion of its pottery, and even during the Glaze II to IV periods it appears to have been under influence from other towns. Only for the century or so of Glaze V did Pecos stand ceramically on its own feet; and in its last years it again fell under outside dominance.

This, as has been said, is somewhat discouraging, for our work at Pecos was undertaken in the hope that it would throw light upon fundamental problems of Southwestern archaeology, and such problems are usually best attacked in nuclear regions. It must be remembered, however, that in 1914, when Pecos was selected for excavation, not even the outlines of Southwestern history had yet been sketched; one field was as likely to yield significant information as another; Pecos was a large site; it was known to have been occupied until a late date; its evidently deep middens not only offered excellent prospects for stratigraphic study, but also bore sherds proving them to run back to Black-on-white times. The Black-on-white wares, at that time, still remained unclassified, nor had it been realized that those of the Rio Grande might be centuries younger than the superficially similar products of other regions. Finally, I was then of the opinion that Southwestern culture was of more directly Mexican origin than has since proved to have been the case; and it seemed to me that migrations from the south might more readily have passed up the Rio Grande valley than across the mountains of western New Mexico and eastern Arizona or the deserts of Arizona's southern border. Hence I thought it possible that below the obviously instructive late deposits, which I was sure existed at Pecos, there might also be found remains illustrating the first stages of Southwestern development. These, of course, were not forthcoming. But the investigations at Pecos have called attention to problems of the diffusion of traits, of the interaction of ethnic groups, of inter-area and intra-regional trade, which, from a broader point of view, are quite as important as those of the origin and primary diffusion of any single culture. As the study of American archaeology progresses and as the relatively easily reconstructed histories of the most sharply marked nuclear cultures are worked out, we shall be required to attempt visualization of New World culture in its entirety. And the soundness of the results which we shall then attain will depend in

large measure upon our ability to interpret just such phenomena as are exemplified at Pecos and other peripheral communities.

So, all in all, it is probably as well that Pecos was chosen rather than some more ancient and more centrally located ruin in the San Juan or the Little Colorado. The excavations at Pecos played a useful part in the growth of Southwestern archaeological field technique, and the site was large enough to permit us to work for a number of years without exhausting its cemetery-rubbish heaps or much more than sampling the buildings. Thus ample materials still remain for examination by the better equipped students of the future, while a pueblo less extensive might have been cleared completely and much invaluable evidence have been destroyed. The partial and possibly ill-interpreted results of our necessarily experimental work can therefore still be reviewed by others.

Outstanding among the many useful lessons learned is that we should have dug less each season. As it was, we hardly had time to complete the routine care of the one summer's collections before we had to take the field again. Hence, in spite of one or two lay-offs when a certain amount of study was done, we never really caught up, there was never opportunity thoroughly to digest our findings, formulate problems, and plan intelligently for coming campaigns. It has also been demonstrated by the Pecos investigation that it is most essential for technological research to go hand-in-hand with excavation. Had we been in possession of Miss Shepard's findings before field-work ceased we would have paid far more attention than we did to certain deposits, and all stratigraphic situations would have been better handled.[1] For instance, it is now clear that we should have taken a greater number of more careful tests in late Black-on-white and early Glaze I strata, and should have been more keenly on the lookout for beds of unmixed refuse dating from those horizons. Had we done so we might well have determined whether or not the local manufacture of decorated pottery, in the form of Rowe Black-on-white, persisted through the span of years during which we think Glaze I was being imported. Another still moot point which might have been settled concerns the exact chronological relation of Local Glaze I Red to Glaze II. Our data regarding the percentages of Local Glaze I Red and other contemporaneous types are also very poor. This is due to the fact that Local Glaze I Red was not even recognized as a separate type until several seasons had elapsed (it was not mentioned in the first report on Pecos pottery—Kidder, M. A. and A. V., 1917); nor was its importance as the earliest Pecos Glaze realized until Miss Shepard's determination of the nature of its tempering material proved that it was not merely a short-lived, degenerate form of Glaze I Red. Hence its unprepossessing sherds were at first entirely ignored, nor, even later, was it given the special attention which it deserved. The result was that Local Glaze I Red is practically absent from the selected lots.

The case of Local Glaze I Red is only one of several in which our practice of choosing for preservation what we considered to be "typical" pieces has left us with inadequate representation of material which has since turned out to be signi-

[1] Practical and theoretical aspects of stratigraphic excavation will be considered in the section on field methods in the final volume of this series.

ficant. Our mistake lay in not saving for laboratory study more unselected lots from the pockets of débris that were encountered in abandoned rooms, in kivas, under plaza floors, and elsewhere. Such beds are extremely valuable because, having accumulated rapidly and having subsequently remained undisturbed, they preserve a much better sample of the wares in use at the time of their deposition than can be recovered from the more or less impure strata of long-used middens.[1] This was indeed realized during the excavations, and the sherds from pockets of this sort were always carefully studied, classified, and counted, and the proportions of the different wares and types were listed. The resulting statistics have been among the most useful of all our field notes. But they are nevertheless far from satisfactory, because, not having as yet analyzed the Pecos decorations, I was still unaware of the meaning of, and therefore failed to record, specimens illustrating various interesting categories of design; nor at that time had Miss Shepard yet begun her researches. Even had we been in possession of her findings, we could not have identified in the field those subtypes which are distinguished by tempering material and other technological peculiarities, and whose recognition therefore requires laboratory examination.

It is seldom practicable, of course, to save the entire pottery content of even small beds of refuse. Some system, however, such as screening every sherd from a cubic yard of earth, should be used to insure representation of all types and subtypes, and to permit calculation of percentages. Materials so gathered would constitute true random samples to serve as checks upon the selected materials that naturally always make up the bulk of a collection.

In the introduction to the first volume of this work the great usefulness of pottery in archaeological research was stressed. It was shown that familiarity with types and knowledge of their chronological sequence are necessary for the student who wishes quickly to learn the cultural affinities of sites, to determine their relative ages, and to reach preliminary formulation of the major problems of his field. The descriptions of the pottery of Pecos and the discussions by Mr. Amsden, Miss Shepard, and myself have been written with the above requirements in mind. We have striven to present our data in such a way as to render them of immediate service for survey purposes as well as for the detailed comparative studies of the art and the technological properties of Southwestern pottery, both Hohokam and Anasazi, which we are convinced must eventually be carried out if we are to attain full understanding of the development of culture in this area. The Pecos materials, however, can also throw light upon questions of more general interest. Pottery, as has long been realized, offers exceptional opportunity for research upon the processes and the psychology of primitive art.

Research upon primitive art has been greatly hampered by lack of chronological perspective. Most collections of pottery and other artifacts represent no more than a single, usually a rather short, period. So seldom has it been possible to deal with specimens covering long stretches of time that few data are available regarding the nature, rate, and underlying causes of decorative evolution. For such studies the chronologically seriable Pecos types should be of much value, although, as we have

[1] The causes of mixing in rubbish heaps are discussed in Vol. I, p. 10.

also seen to be the case in the archaeological investigation, they cannot contribute to the fullest extent until supplemented by similar series from neighboring regions.

I had hoped to point out, in the present volume, the bearing of Pecos pottery upon various problems of primitive art. I had wished to show the influence of the use of glaze paints upon design; to discuss the relation between pictography, ceramic decoration, and the ornamentation of ceremonial objects; to take up the very interesting questions of symbolism, naturalism, and conventionalization; to follow the development, and inquire into the meaning, of such motifs as the *awanyu*, the *capitan*, the bird. But I have found, as I should of course have realized, that to do justice to these subjects more time would have to be devoted to the voluminous literature of decoration and to comparative studies of other groups of Anasazi pottery than is, at present, available.

Many problems have been formulated in the foregoing pages. Some of them will doubtless never be solved, for ruins containing indispensable links in the chain of evidence may well have been destroyed by the forces of nature or by man; other evidence may elude the most careful search. Certain of our queries, however, can surely be answered in full; upon a greater number we can ultimately throw at least much light. But further progress depends on further work of the most intensive and intelligent sort. So the real question which confronts us is whether or not such research is worth while, in other words, whether many of our more detailed problems are really worth solving? This is a difficult matter for me to consider impartially. I have been preoccupied for so many years with Pecos and with its relation to the other ruins of the Rio Grande that I may well attach undue importance to matters of little moment; I may well, as the saying goes, be failing to see the forest for the trees. With this situation all Southwestern archaeologists must sooner or later come to grips. To what extent should they refine their researches? One can imagine them, in a field so rich, pushing their investigation to the point of hair-splitting sterility.

Consideration of this aspect of things is necessary because North American archaeology is badly out of balance. We already know vastly more about the pre-Columbian history of the Southwest than we do regarding that of any other part of the country. This, of course, is owing to the fact that its ruins are so abundant, so well-preserved, so spectacular, and so prolific in specimens that the Southwest has drawn to itself a host of students. Much the same situation obtains in Middle America, where the magnificent relics of the Maya civilization have attracted a preponderance of attention. The Southwesternist, or the student of the Maya, counters any unwelcome suggestion that he is over-specializing by stating that his field is nuclear, that until its problems are settled those of surrounding cultures cannot intelligently be attacked. I have used this argument myself. It is a dangerous one, because it carries so considerable an amount of truth. For it is certainly the case that we cannot hope, within any reasonable time at least, to cover the whole continent with investigation thorough enough to yield valid returns. Archaeologists are too few, funds are insufficient. It would seem, therefore, that we should devote ourselves to such areas as may be expected to pay the largest and quickest dividends of significant historical information.

What to do? Should we temporarily lessen our effort in the Southwest and give

attention to other relatively unworked regions? Possibly. But we have now reached a stage in Southwestern research where results are cumulative; where every new fact has immediate bearing upon a host of other facts; where, in other words, the picture is beginning to take shape and every added stroke gives it fuller meaning.

As recently as 1924, when I gathered together in "Southwestern Archaeology" the data then available as to the history of the Pueblos and their predecessors, it seemed that we knew a great deal about our subject. But in the past decade that book has become obsolete. Douglass's tree-ring studies have provided a firm chronological backbone; a flood of light has been cast on the earlier periods in the north; in the south the Hohokam have emerged, and more knowledge of them may yet revolutionize our whole conception of Southwestern origins; nomenclature is gradually being standardized and a workable taxonomy is emerging. Another ten years can confidently be expected to bring even greater advances. Ceramic technology, still in its infancy, gives promise of results not less far-reaching than those of dendrochronology. Environmental studies, long ago demanded by Kroeber, and the closer coördination of archaeological and ethnological research, will greatly increase our ability to interpret the ever-increasing corpus of data.

So the Southwesternist argues. It is naturally difficult to convince him that he should postpone his fascinating and profitable tillage to turn the sod of untried fields. But, on the other hand, how can the Southwest be understood without information regarding ajdoining areas: the western Plains, northern Mexico, the Pacific Coast; or, farther afield, the Mound Country and the Middle American plateau? What meaning will Southwestern history possess if it remains an isolated phenomenon? If it so remains, its devotees will increasingly be exposed to the danger, that threatens all archaeologists, of becoming more and more immersed in local detail, further and further preoccupied with facts about things and less and less perceptive of the meaning of things in terms of the laws which have governed man's long, slow struggle toward a higher plane of existence.

So again I query, what should we do? It would seem desirable that work in such areas as the Southwest and the Maya country should continue, and continue to be refined. Peru must some day be attacked in the same way. But how to keep our research intellectually broad enough and sufficiently extensive geographically to give us proper range of vision and adequate depth of perspective? To spread a network of surveys and excavations over the whole New World is too great an undertaking to be contemplated with such resources as we now have, or are likely to acquire for many years to come. Should we cease, for a while, to specialize; and take stock, so to speak, of the larger situation by means of relatively superficial surveys? Should we attempt to develop a group of men with more general interests? Can we persuade the specialist to generalize a bit more about his findings; and to do so in a manner sufficiently clear to induce specialists in other fields to read what he writes? Can we diffuse our efforts without loss of the conscientious accuracy inculcated by intensive research?

These are questions I cannot answer. As I have said, I am too close to the Southwest in general and to Pecos in particular. But that sooner or later they must seriously be grappled with is obvious. And the case of Pecos, it seems to me, bears

directly upon all of them, for Pecos stands in much the same relation to the Southwest as does the Southwest to North, or the Yucatan Peninsula to Middle, America.

The work at Pecos was neither as intelligently done nor as thorough as it might have been. Nevertheless, at no Southwestern site have excavations been carried on for so long, nor have the skeletons and artifacts of any other large ruin been studied so carefully or published so fully. For better or worse, it exemplifies the intensive method of attack. The results obtained may therefore perhaps be of value not only for the light they shed upon the archaeology of the Rio Grande, but also by providing material for reaching decision as to how we should, in future, apportion our labors. In the Southwest, there is at present a distinct trend away from the Pecos type of investigation. The large-site, long-time excavation has generally been superseded by surface surveys, small reconnaissance digs, search for specimens of datable wood, activities which all bring quicker and more widely applicable results. I believe that at the moment these are needed. Of late I have, indeed, been advocating a similar decentralization of effort in the Maya field. But if the work is not to lapse into superficiality, students must keep constantly in mind the limitations of such techniques, must not pile hypothesis upon unverified hypothesis, and must be willing to face the necessity of periodic return to intensive investigation.

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